2.15 WETLANDS BASELINE

Scientific Aquatic Services (SAS) was appointed to conduct a wetland assessment as part of the EIA and EMPR Addendum process for the Glencore Merafe Boshoek Mine and Plant (GMBS). A concise summary of the general findings of this assessment is discussed in this section. Additionally, the complete Wetlands Specialist Report is attached as **APPENDIX 2.15 (A)**.

2.15.1 General Importance of the Study Area

The study area falls within the Bushveld Basin and Western Bankenveld Aquatic Ecoregions and is located within the A22F quaternary catchment which is classified as a Class D (largely modified) system and is targeted to be managed as a Class C (moderately modified) system (DWA 1999).

The major drainage features on the study area are the Matlapyane and Borethane streams.

Four wetland systems were identified on the study area; namely the Matlapyane and Borethane wetland systems, the Southern wetland feature and the Marang wetland feature (see Figure 2.15.1 (a)).

The SANBI Wetland Inventory (2006) and National Freshwater Ecosystem Priority Areas (NFEPA) (2011), databases were consulted to define the aquatic ecology of the wetland or river systems close to or within the study area that may be of ecological importance.

The study area falls within the Crocodile (west) and Marico Water Management Area (WMA). Each Water Management Area is divided into several sub-Water Management Areas (subWMA), where the catchment or watershed is defined as a topographically defined area which is drained by a stream or river network. The Sub-Water management unit indicated for the study area is the Elands sub-WMA.

No NFEPA wetlands or flagship rivers were identified within or immediately adjacent to the study area. In addition, no wetland clusters of conservational importance were indicated within or near the study area.

The applicable Freshwater Ecosystem Priority Areas (FEPA) WMA data do not indicate any riverine resources within or in the vicinity of the study area which is of significance in terms of fish conservation.

Wetlands located within the study area are not shown to provide breeding habitat for cranes.

Additionally, no RAMSAR wetlands are located within or close to the study area and no wetlands are indicated to fall within 500 m of an IUCN threatened frog point locality.

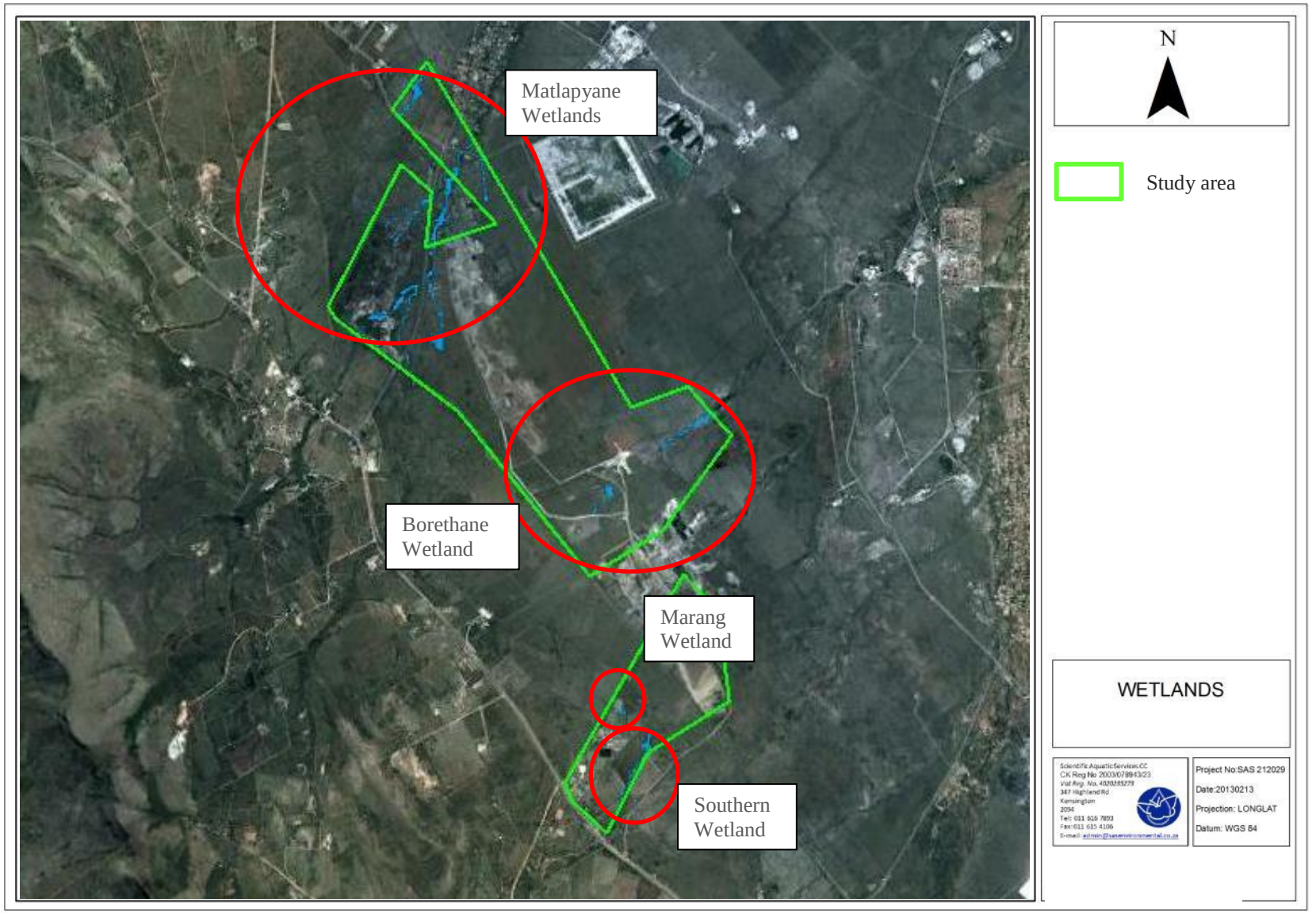

Figure 2.15.1 (a): Wetland features identified within the study area.

2.15.2 Wetland System Characterisation

Following the SANBI National Wetland Classification system, the Matlapyane and Borethane wetland systems, as well as the Southern wetland feature may be defined as channelled wetlands associated with streams and rivers, while the Marang wetland feature in the south of the study area is best described as a depression wetland (refer to Table 2.15.2 (a) and (b)).

Table 2.15.2 (a): SANBI National Wetland Classification for the Matlapyane, Borethane and Southern Wetland Systems

Level 1: System	Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
			HGM Type	Longitudinal zonation / landform
Inland: An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	The study area falls largely within the **Bushveld Basin** and **Western Bankenveld** Aquatic Ecoregions.	**Valley floor** The typically gently sloping, lowest surface of a valley	**Channel**: an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies.	**Upper Foothill River:** Overland flow from catchment runoff, concentrated surface flow from upstream channels and tributaries, diffuse surface flow from an unchannelled upstream drainage line (i.e. an unchannelled valley-bottom wetland), seepage from adjacent hillslope or valleyhead seeps, and/or groundwater (e.g. via in channel springs).

Table 2.15.2 (b): SANBI National Wetland Classification for the Marang Wetland systems.

Level 1: System	Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
			HGM Type	Longitudinal zonation / landform
Inland: An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	The study area falls largely within the **Bushveld Basin** and **Western Bankenveld** Aquatic Ecoregions, with the Marang wetland feature located exclusively within the **Western Bankenveld** Aquatic Ecoregion.	**Valley floor** The typically gently sloping, lowest surface of a valley.	**Depression wetland:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.	**Valley-bottom flat:** A near-level wetland area with little or no relief and lacking depressional characteristics, forming part of a broader valley-bottom wetland complex

2.15.3 Wetland Function Assessment

The wetland function and service provision assessment indicated an intermediate level of ecological function and service provision for the Matlapyane (see Table 2.15.3 (a) and Figure 2.15.3 (a)) and Southern Wetland (Table 2.15.3 (b) and Figure 2.15.3 (b)) features.

These systems play an important role in flood attenuation, streamflow regulation and erosion control, but has lowered importance in terms of socio-economic services.

Table 2.15.3 (a): Wetland functions and service provision for the Matlapyane Wetland system.

Ecosystem Service	Wetland
Flood attenuation	2.4
Streamflow regulation	2.1
Sediment trapping	1.6
Phosphate assimilation	1.7
Nitrate assimilation	1.7
Toxicant assimilation	2.2
Erosion control	2.4
Biodiversity maintenance	2.4
Carbon Storage	1.3
Water Supply	0.7
Harvestable resources	0.6
Cultivated foods	0.6
Cultural Significance	0.3
Tourism and recreation	0.3
Education and resource	0.3
SUM	**20.6**
Average score	**1.4**

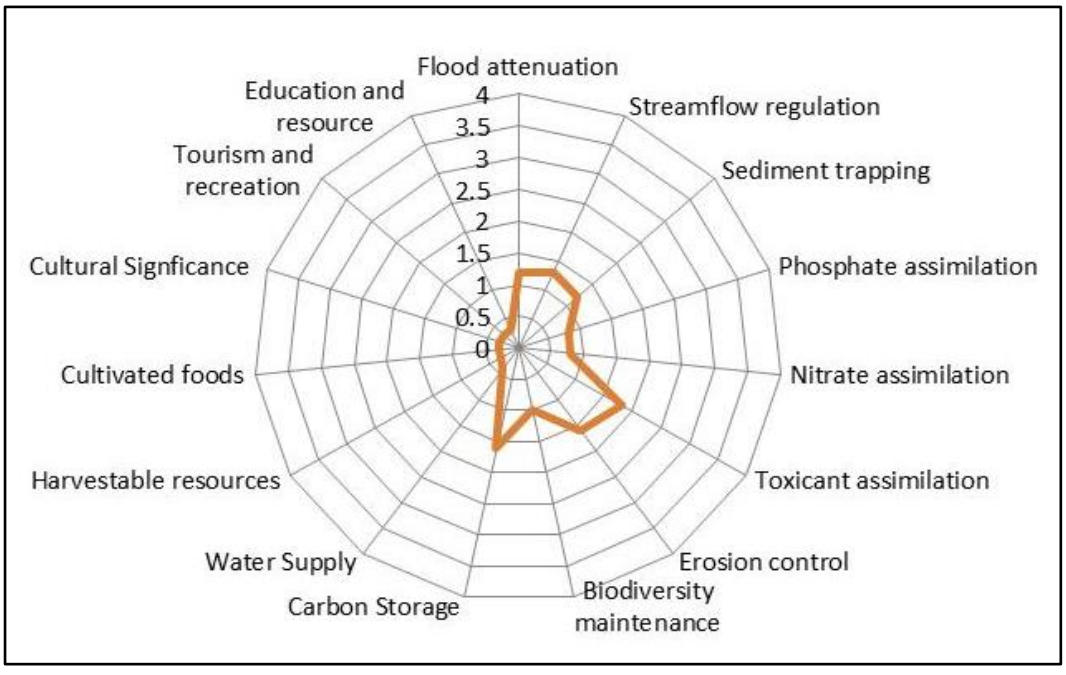

Figure 2.15.3 (a): Radar plot of wetland services provided by the Matlapyane Wetland system.

Table 2.15.3 (b): Wetland functions and service provision of the Southern Wetland feature

Ecosystem Service	Wetland
Flood attenuation	2.5
Streamflow regulation	2.4
Sediment trapping	2.4
Phosphate assimilation	1.7
Nitrate assimilation	1.8
Toxicant assimilation	1.5
Erosion control	2.4
Biodiversity maintenance	2.3
Carbon Storage	1.6
Water Supply	1.4
Harvestable resources	0.6
Cultivated foods	0.3
Cultural Significance	0.3
Tourism and recreation	0.3
Education and resource	0.3
SUM	**21.8**
Average score	**1.5**

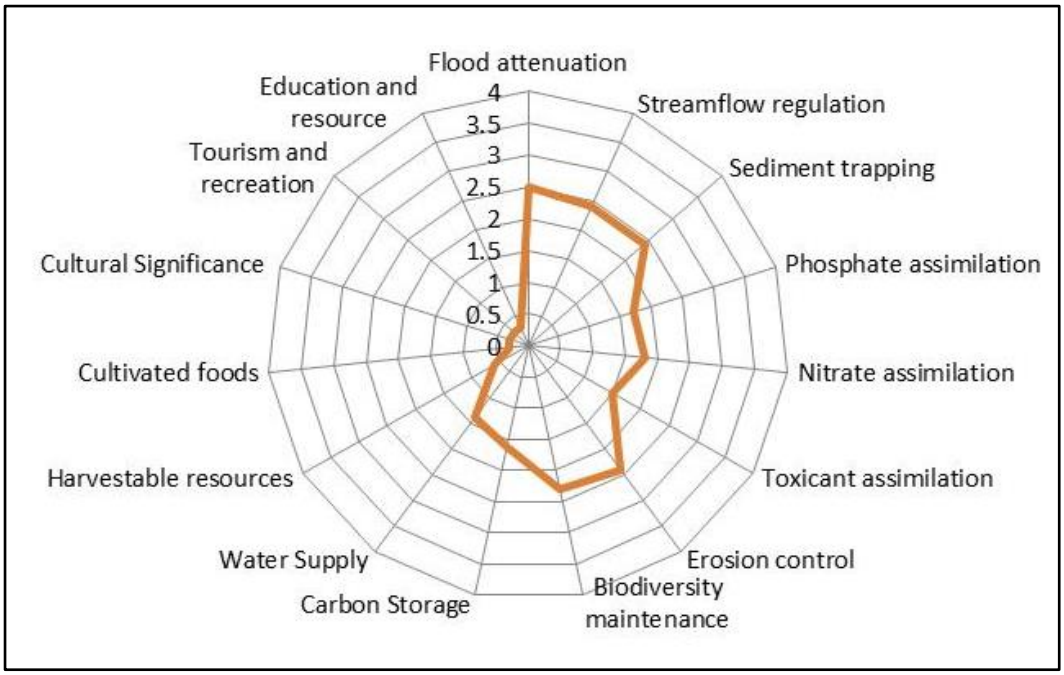

Figure 2.15.3 (b): Radar plot of wetland services provided by the Southern Wetland Feature

The wetland function and service provision assessment for the Borethane (Table 2.15.3 (c) and Figure 2.15.3 (c)) and Marang Wetland (Table 2.15.3 (d) and Figure 2.15.3 (d)) features, indicated a moderately low level of ecological function and service provision.

The Borethane Wetland plays a role in streamflow regulation, erosion control and toxicant accumulation. Due to the transformation of vegetation in the vicinity of the wetland, the feature provides little function in terms of habitat provision, harvestable resource provision and other socio-economic aspects.

Table 2.15.3 (c): Wetland functions and service provision for the Borethane Wetland System

Ecosystem Service	Wetland
Flood attenuation	1.2
Streamflow regulation	1.3
Sediment trapping	1.2
Phosphate assimilation	0.8
Nitrate assimilation	0.8
Toxicant assimilation	1.8
Erosion control	1.6
Biodiversity maintenance	1
Carbon Storage	1.6
Water Supply	0.4
Harvestable resources	0.3
Cultivated foods	0.3
Cultural Significance	0.3
Tourism and recreation	0.3
Education and resource	0.3
SUM	**13.2**
Average score	**0.9**

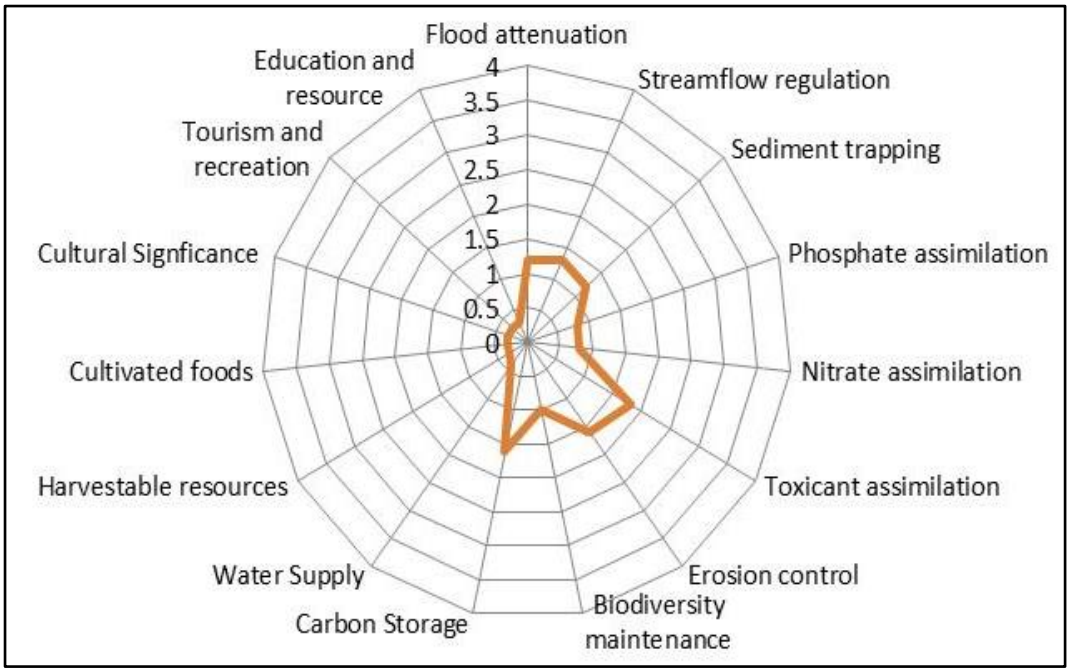

Figure 2.15.3 (c): Radar plot of wetland services provided by the Borethane Wetland System

The Marang Wetland feature, comprising an exhorheic depression with input from precipitation, diffuse surface flow and groundwater, does not provide any significant benefit in terms of streamflow regulation, erosion control or sediment trapping. It also does not contribute significantly towards enhancement of water quality, but does however provide limited benefit in terms of nitrate and toxicant accumulation. From the results of the assessment it is evident that the feature provides an overall a moderately low level of ecological function and service provision.

Table 2.15.3 (d): Wetland functions and service provision of the Marang Wetland Feature

Ecosystem Service	Wetland
Flood attenuation	0.9
Streamflow regulation	1.3
Sediment trapping	1.2
Phosphate assimilation	0.8
Nitrate assimilation	0.8
Toxicant assimilation	1.4
Erosion control	0.8
Biodiversity maintenance	1.4
Carbon Storage	1.6
Water Supply	0.3
Harvestable resources	0.3
Cultivated foods	0.3
Cultural Significance	0.3
Tourism and recreation	0.3
Education and resource	0.3
SUM	**12.0**
Average score	**0.8**

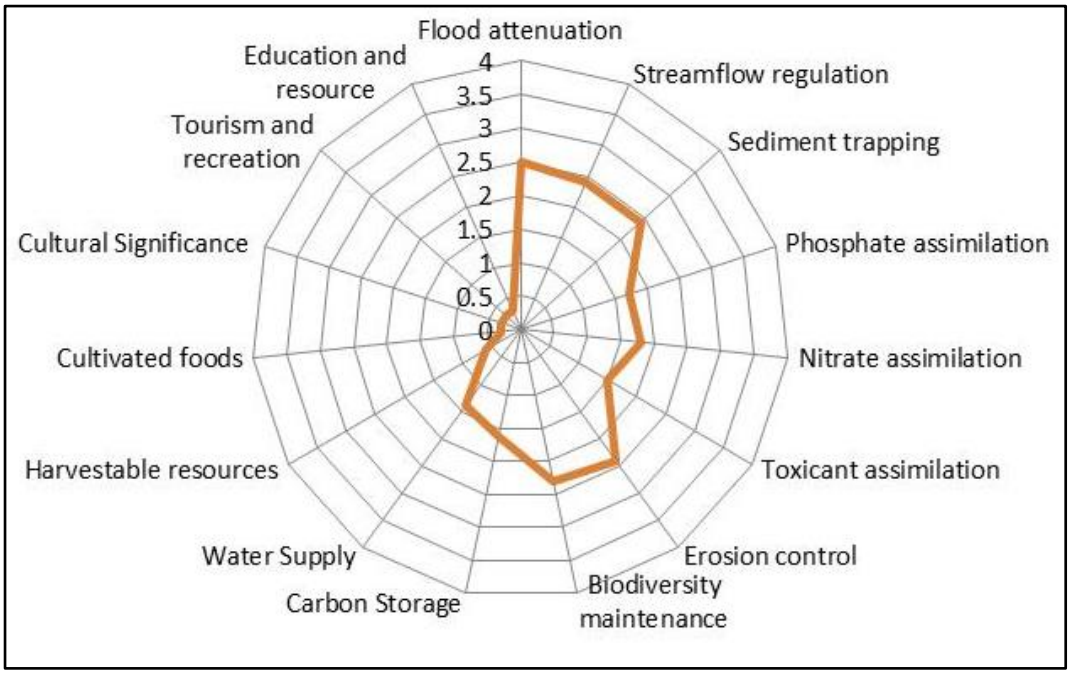

Figure 2.15.3 (d): Radar plot of wetland services provided by the Marang Wetland Feature

2.15.4 Present Ecological State (PES)

The wetland features' Present Ecological State were determined to fall within class C – Moderately Modified for the Matlapyane, Southern and Marang Wetland features.

Canalisation, the construction of dams and topographical alteration, particularly within the plant area, as well as the presence of alien plant species contribute towards the PES score of the Matlapyane Wetlands feature. Additionally, impacts on the Marang Wetland feature include terrestrial vegetation encroachment, topographic alteration and perceived water quality modification as a result of adjacent sports fields and irrigation thereof.

Stormwater within the Royal Marang Hotel grounds have been channelled so as to discharge within the wetland, which may further influence water quality.

Conversely, the PES for the Borethane Wetland was determined to fall within class D – Largely modified. This score was obtained due the canalisation and topographical alteration of the system as well as vegetation and habitat transformation.

2.15.5 Ecological Management Class (EMC)

The results obtained from the wetland assessment indicate overall high levels of transformation on all levels of ecology and functionality for the Matlapyane, Borethane and Marang Wetland features. Therefore, the Ecological Management Class (EMC) class deemed appropriate to enhance and maintain currently ecology as well as functionality of these feature is Class D (Largely modified).

The EMC class deemed appropriate to manage the Southern Wetland feature, considered to have a slightly enhanced overall ecological condition, is class C (Moderately modified).

2.15.6 Wetland Delineation and Sensitivity Mapping

A 32 m buffer zone was deemed adequate to conserve the various wetland features, maintain the Present Ecological State and limit any further impact future rehabilitation could have and to maintain the ecological management class determined by the South African Wetland Assessment Classification System, while a 100 m buffer zone is indicated around all riparian features as per Regulation GN 704 of the National Water Act, 1998.

The Wetland delineation map for the Matlapyane Wetland system is depicted in Figure 2.15.6 (a), for the Borethane Wetland system in Figure 2.15.6 (b), for the Southern Wetland feature in Figure 2.15.6 (c) and for the Marang Wetland feature in Figure 2.15.6 (d).

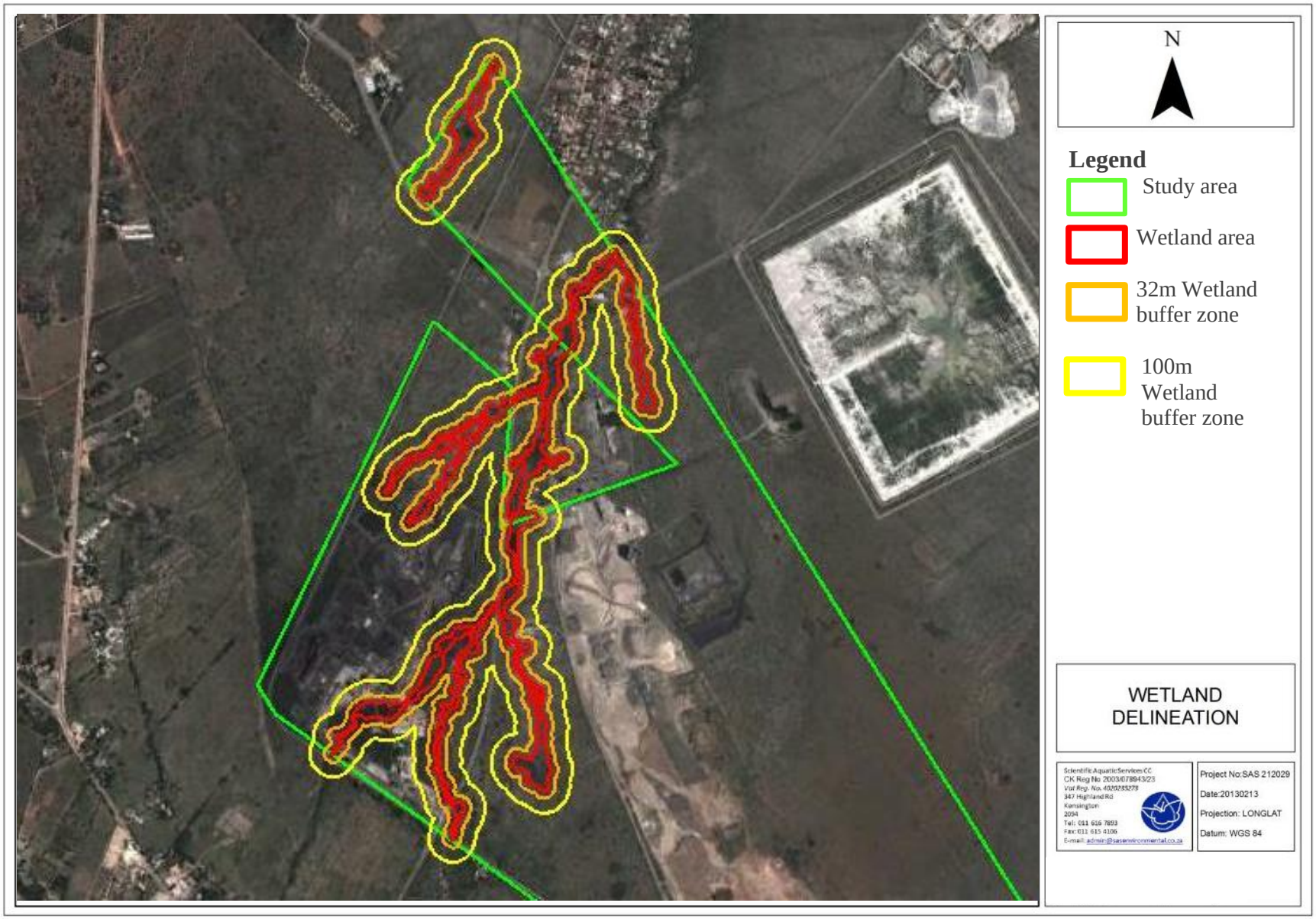

Figure 2.15.6 (a): Wetland delineation map for the Matlapyane Wetland System

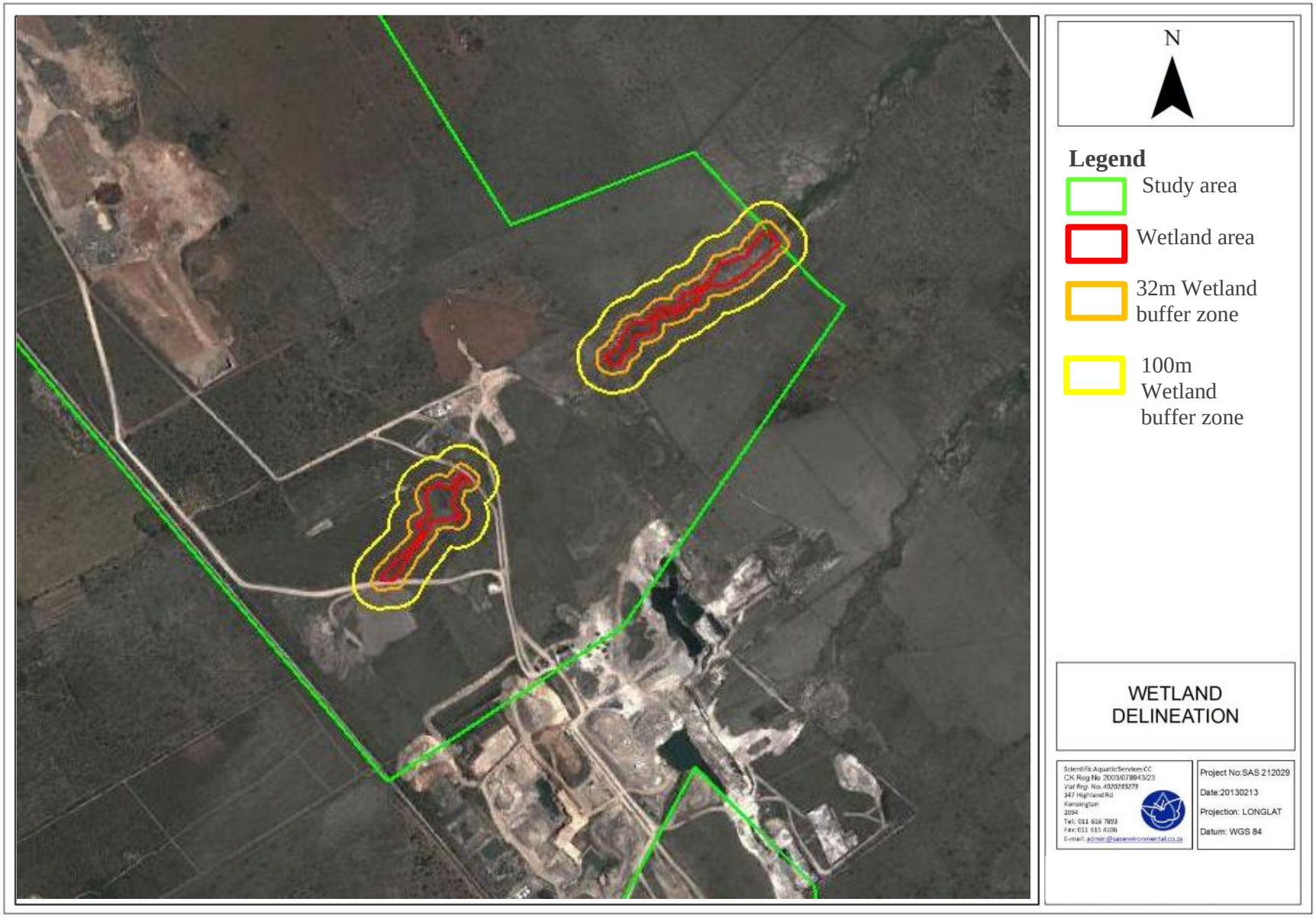

Figure 2.15.6 (b): Wetland delineation map for the Borethane Wetland System

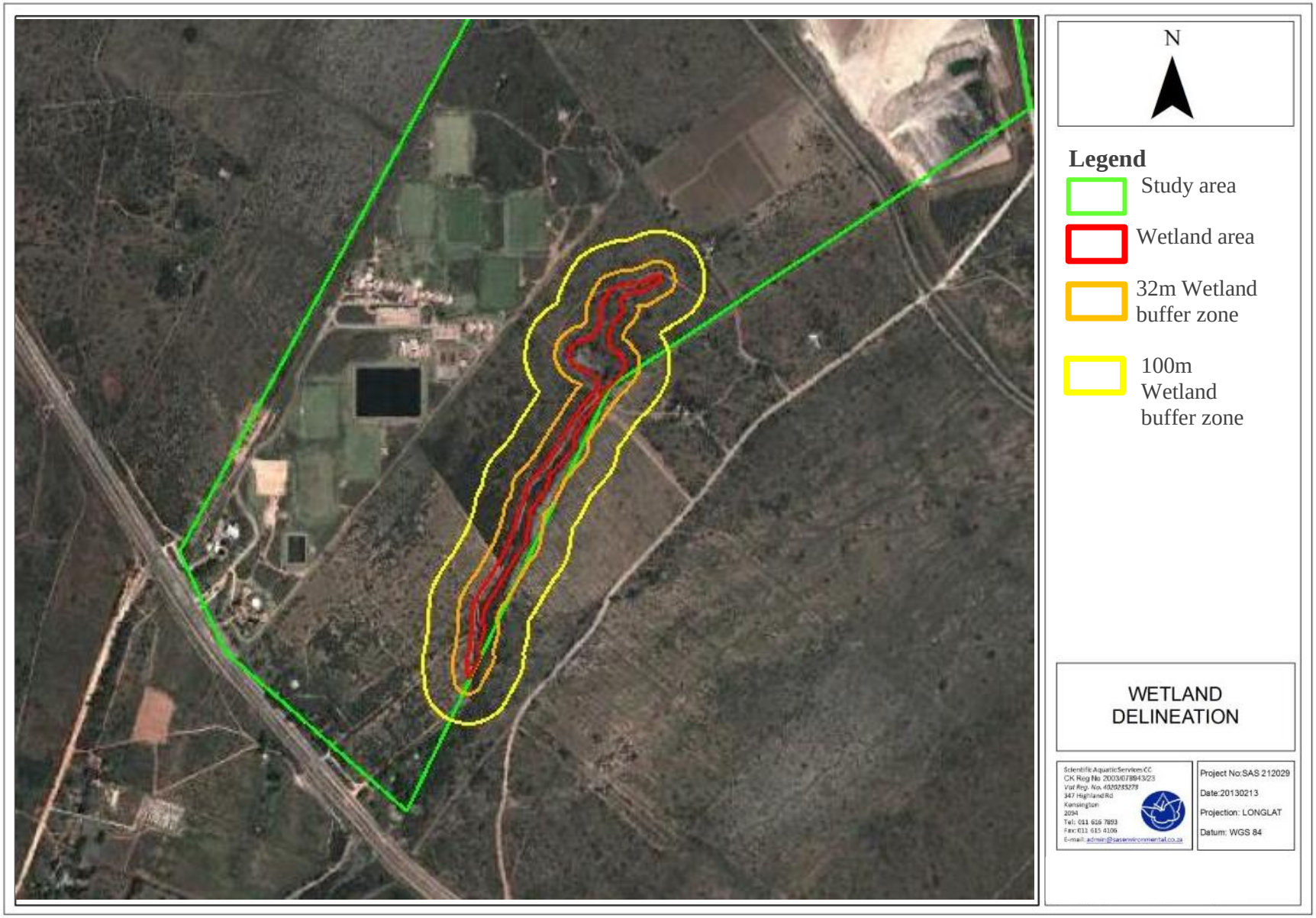

Figure 2.15.6 (c): Wetland delineation map for the Southern Wetland Feature

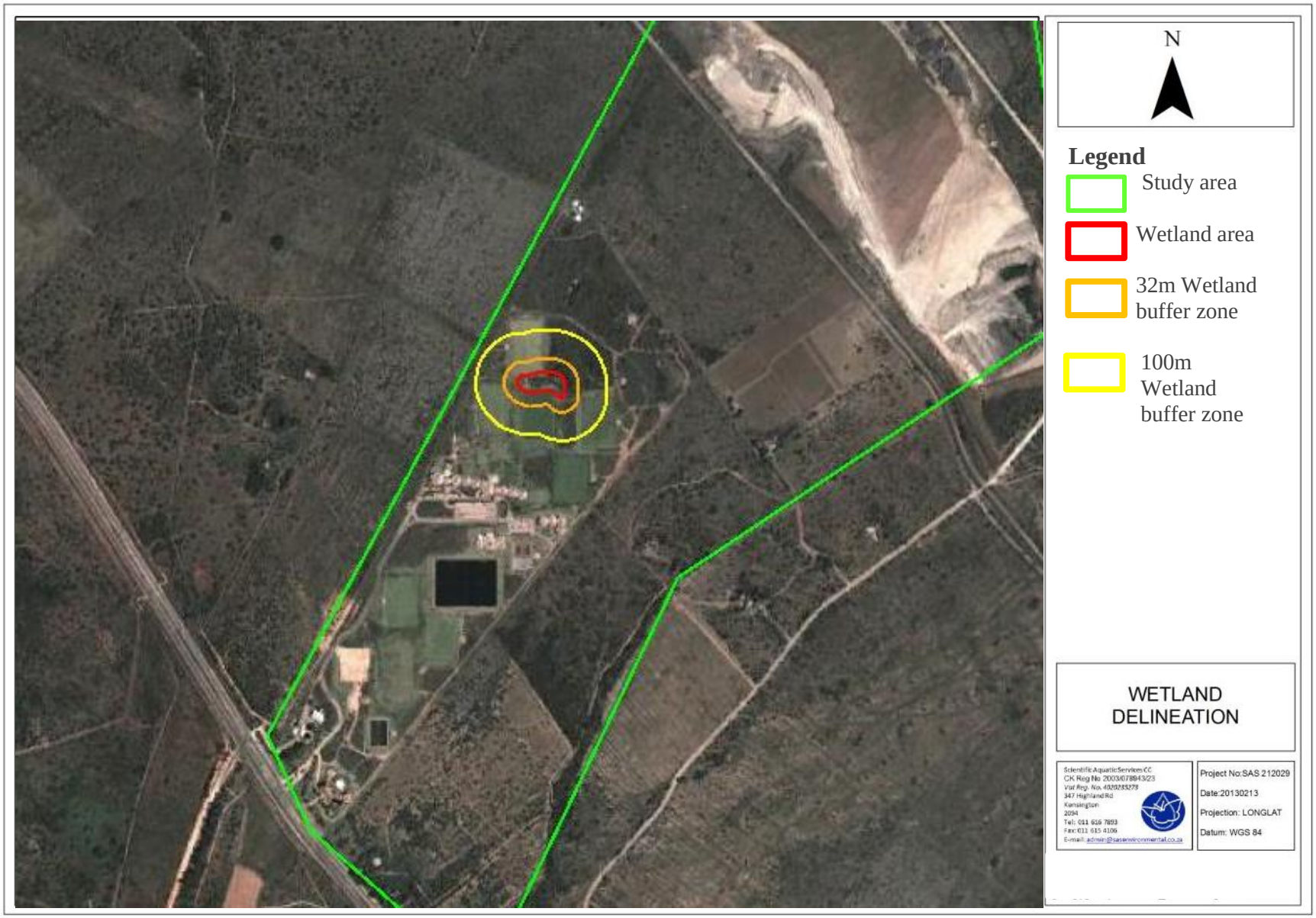

Figure 2.15.6 (d): Wetland delineation map for the Marang Wetland Feature

2.16 AQUATIC ECOSYSTEMS BASELINE

Scientific Aquatic Services (SAS) was appointed to conduct an aquatic ecosystems assessment as part of the EIA and EMPR Addendum process for the Glencore Merafe Boshoek Mine and Plant (GMBS). A concise summary of the general findings of this assessment is discussed in this section. Additionally, the complete Aquatic Ecosystems Specialist Report is attached as **APPENDIX 2.16 (A)**.

The GMBS study area is flanked by the Magaliesberg Mountain Range to the west and south-west and by the Pilanesberg to the north. The subject property (and study area) falls within an ecotone between the Bushveld Basin and Western Bankenveld Aquatic Ecoregions and is located within the A22F quaternary catchment. The Matlopyane Spruit is a non – perennial tributary of the Elands River.

The site is located in the Crocodile (West) and Marico Water Management Area. The land use adjacent to GMBS is dominated by agricultural and mining related activities, leaving the surrounding areas largely transformed. The ecological assessment was therefore confined to the subject property and did not include an ecological assessment of surrounding properties. The surrounding area was however considered as part of the desktop assessment of the area.

2.16.1 Visual Assessment

The assessment site was investigated in order to identify visible impacts on the site, with specific reference to impacts from surrounding activities and any effects activities occurring upstream in the catchment. Both natural constraints placed on ecosystem structure and function, as well as anthropogenic alterations to the system, were identified by observing conditions and relating them to professional experience.

Factors which were noted in the site specific visual assessments included the following:

- Stream morphology;
- Instream and riparian habitat diversity;
- Stream continuity;
- Erosion potential;
- Depth flow and substrate characteristics;
- Signs of physical disturbance of the area and
- Other life forms reliant on aquatic ecosystems.

Refer to Figure 2.16.1 (a) for the assessment sites located in the study area.

Figure 2.16.1 (a): Assessment Points indicated on an Aerial Photograph

Table 2.16.1 (a): Description of the Location of the Assessment Sites in the Study Area

SITE	SW 1B	SW 2A	SW 2B	SW3
Upstream Features	Located in a largely rural area. A small commercial area occurs upgradient of the point and agricultural activities dominate the landscape immediately upstream of the point.	Located on the downstream of the GMBS smelter. The site will indicate if there are any problems occurring in the system due to the activities associated with the GMBS by comparing the data to the upstream SW1B site.	Located on the downstream side of the GMBS haul road and will indicate any impact from the haul road crossing and associated activities.	The site is located adjacent to the plant and between two dams. This point is of limited use in aquatic ecological assessments but water quality data from this point may assist in interpreting the biological data obtained.
Downstream Significance	The site serves as a reference point for the other sites lower down in the study area.	The areas below this point consist of open veld within the GMBS mining area. The system downstream of this point has seen some physical disturbance and discharges form mining activities into the system take pace. The system is a tributary of the Elands River.	The site is upstream of the plant and may assist in defining conditions prior to impact form the smelter complex.	The site is located between two dams and adjacent to the plant. The site will allow some differentiation in impacts between the plant and the office blocks further downstream.
Significance of the Point	The site serves as a spatial reference point on the system upstream of impacts from the GMBS.	The site serves to indicate the cumulative impact that the GMBS plant has on the system where water leaves the plant and enters the adjacent GMBS mining area	The site serves to indicate any potential impacts from the haul road crossing on the system.	The site indicates impacts on the system in the vicinity of the plant.
Riparian Zone Characteristics	The riparian zone is fairly disturbed and has seen impacts on vegetation cover. Significant impact from alien tree invasion has also occurred.	The riparian zone at this point consists of a mix of grasses, sedges, reeds and Acacia thorn trees. Some agricultural weeds are also evident in the area	The riparian zone at this point consists of a mix of grasses, sedges, reeds and Acacia thorn trees. Some agricultural weeds are also evident in the area.	The assessment point occurs between two dams and the area is dominated by obligate wetland vegetation with special mention of Typha capensis and various sedges
Algal Presence	No algal proliferation was evident during the April and October assessments.	No algal proliferation was evident at the April and October assessment.	No algal proliferation was evident during the April and October assessment.	No algal proliferation was evident during the April and October assessment.
Visual indication of an impact on Aquatic Fauna	Increased turbidity during April indicates that some impact on the aquatic community may occur.	None observed although some loss of stream flow was evident during April and October.	No clear visual indication of impact evident but some loss of stream flow observed.	Impoundments on the system may affect stream flow and will affect habitat and flow conditions as well as migratory connectivity

Table 2.16.1 (a) continued: Description of the Location of the Assessment Sites in the Study Area

SITE	SW 1B	SW 2A	SW 2B	SW3
Depth Characteristics	The system had limited depth diversity with all areas being less than 0.5m deep. The system is dominated by riffles and glides at this point during April, while it is confined to small pooled area in October.	The system had limited depth diversity with most areas being less than 0.5m deep. Some deeper pools were observed during the April assessment. The stream was dry during the October assessment.	The system had limited depth diversity with all areas being less than 0.5m deep. No deeper pools were observed during the April and October assessment.	The dams on either side of the crossing are deep and can support suitably adapted fish and macro-invertebrate species
Flow Condition	There was relatively low flow present at the time of assessment and the flow can be regarded as slow to moderate throughout the system. The habitat conditions present provide fair habitat for aquatic macro-invertebrates and fish and some species requiring very fast flowing water are likely to be absent from the system.	Under the relatively low flow conditions, there is limited flow present and the flow can be regarded as slow throughout the system during the April assessment. Stream was dry during the October assessment.	Under the relatively low flow conditions, there is limited flow present and the flow can be regarded as slow to still throughout the system during the April assessment. The habitat conditions during the October assessment provide an unfit habitat for sampling.	Water is still in the impoundments on either side of the crossing.
Water Clarity	Water is clear during April and October assessments.	Water is relatively clear during the April assessment. The stream was dry during the October assessment.	Water is relatively clear during the April and October assessment.	The water in the upstream dam is clear while water in the downstream dam was clearer.
Water Odour	No odours were evident during April and October.	No odours were evident during April and October.	No odours were evident during the April and October assessment.	No odours were evident during the April and October assessment.
Erosion Potential	Limited potential for erosion is present, except under high flow conditions, due to the well vegetated banks and limited flow.	Limited potential for erosion is present due to well vegetated banks and no flow.	Limited potential for erosion is present, even under high flow conditions, due to the well vegetated banks that have shallow gradients.	No potential for erosion is evident

2.16.2 Physico-Chemical Water Quality

At the SW 1B site the Electrical Conductivity (EC) is low indicating that water entering the plant areas has a low salt concentration and can be considered to be in a relatively good condition.

The EC for SW 3 is low, indicating that there is no to little salt input into the system at this point.

The EC in the SWD is highly elevated from natural conditions and may have an impact on the receiving environment if released.

The pH may be considered natural and no impact on the aquatic ecology of the system is deemed likely as a result of altered pH throughout the area.

Dissolved oxygen (DO) concentrations are adequate at site SW 1B and SW 3.

DO in the SWD is fair and is not likely to impact should water from the SWD enter into the receiving environment.

Temperatures can be regarded as normal for the time of year and time of day when assessment took place.

Since April 2012, the EC at SW 1B and the SWD has increased by 55.7% and 55.2% respectively. The EC at SW3 has decreased by 70.8% since April 2012. These changes exceed the DWA (DWAF, 1996) Target Water Quality Range (TWQR) and may have an effect on the receiving environment and the aquatic invertebrates. This increase may be due to seasonal variation and lack of rainfall. A significant impact on the aquatic community due to osmotic stress is deemed likely.

pH values from SW 1B has decreased slightly by 3.6% since April 2012, this change falls within the DWAF TWQR and poses no threat to the receiving environment.

pH at the SWD has decreased by 2.5% to a more normal value for the receiving environment.

DO has increased significantly by 24.2% since the April 2012 assessment and has improved in concentration regarding acceptability at SW 1B.

DO has increased by 5.2% since the April 2012 assessment and has increased in concentration regarding acceptability.

The DO concentration has decreased by 38.6% at the SWD since April 2012. The most likely reason for the reduced dissolved oxygen concentration is an increase concentration of organic material and increase in water temperature at this point. The reduced dissolved oxygen concentrations can be considered as a significant deterioration in the conditions of the SWD system. If effluent from the SWD is introduced into the receiving environment it may pose a threat on the receiving environment.

When compared to the oldest available data of 2002, the EC of April 2012 at SW 1B has decreased by 71.0%, by 83.1% at SW 2B, by 9.7% at SW 2A, and SW 3 has decreased by 9.5% since 2005. The changes exceed the DWA (DWAF, 1996) TWQR for aquatic environments but have decreased to a more acceptable state.

The pH of April 2012 at the SW 1B site has increased by 10.3%, by 5.0% at the SW 2B site, by 11.9% at the SW 3 site since 2002, and SW 2A has increased by 3.3% since the 2005 assessment. The changes exceed the DWA (DWAF, 1996) TWQR for aquatic environments but remain largely natural.

The DO of April 2012 at the SW 1B site has increased by 3.3%, by 7.3% at the SW 2B site, by 65.7% at the SW 3 site, and SW 2B has decreased by 57.5% since 2005. DO has increased to a more acceptable state in sustaining a sensitive aquatic environment.

2.16.3 Habitat Assessment

From the results of the application of the Invertebrate Habitat Assessment System (IHAS) index (see Tables 2.16.3 (a) and (b)), it is evident that, under natural conditions, the aquatic resources in the vicinity of the subject property provide limited habitat conditions for macro-invertebrates and therefore an aquatic macro-invertebrate community of limited diversity and sensitivity can be expected. It is however evident that the habitat at the upstream SW 1B site is better in relation to the sites further down in the catchment and a more diverse and sensitive community can be expected at this point in the system.

Table 2.16.3 (a): Biotope specific summary of the results obtained from the application of the IHAS index to the various sites during April 2012.

SITE	SWB 1	SW 2	SW 2B
Habitat Score	68	55	63
Habitat Adjustment Score (illustrative purposes only)	+21	+34	+25
McMillan, 1998 Habitat Description	Habitat diversity and structure is adequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	Habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.
Stones Habitat Characteristics	Some rocky substrate present in current, which provides habitat for suitably adapted taxa.	No rocky substrate present.	Very little rocky substrate present.
Vegetation Habitat Characteristics	Fair bankside vegetation present, suitable for supporting as diverse invertebrate community.	Fair bankside vegetation present, suitable for supporting as diverse invertebrate community.	Fair bankside vegetation present, suitable for supporting as diverse invertebrate community.

SITE	SWB 1	SW 2	SW 2B
Other Habitat Characteristics	Gravel, sand and mud substrate provides habitat for suitably adapted macro-invertebrates. The muddy substrate potentially allows for some sensitive taxa to be supported at the site.	Most of the stream substrate consists of deep fine mud deposits and as such limits the diversity of the community that can be supported.	Most of the stream substrate consists of hard pavement mud and as such limits the diversity of the community that can be supported.
IHAS General Stream Characteristics	A fairly shallow, narrow stream consisting of a mix of habitats at the time of assessment. The water in the system was turbid at the time of assessment. Riparian vegetation consists mostly of grasses and shrubs. Bankside cover is good but some potential for erosion under higher flows is likely.	A fairly shallow, narrow stream consisting of slow flowing riffles and pools at the time of assessment. The water in the system was turbid at the time of assessment. Riparian vegetation consists of grasses and shrubs. Bankside cover is good.	A fairly shallow, narrow stream consisting of slow flowing glides and pools at the time of assessment. The water in the system was discolored at the time of assessment. Riparian vegetation consists of a mix of vegetation. Bankside cover is good and the shallow gradient banks will not erode excessively quickly.

Table 2.16.3 (b): Biotope specific summary of the results obtained from the application of the IHAS index to the various sites during the October 2012 assessment.

SITE	SWB 1B	SW 2A	SW 2B
Habitat Score	45	NA	NA
Habitat Adjustment Score (illustrative purposes only)	+29	NA	NA
McMillan, 1998 Habitat Description	Habitat diversity and structure is inadequate for supporting a diverse aquatic macro-invertebrate community under the current flow conditions.	NA	NA
Stones Habitat Characteristics	Some rocky substrate present, providing little habitat for supporting a diverse invertebrate community.	NA	NA
Vegetation Habitat Characteristics	Bankside vegetation not present.	NA	NA
Other Habitat Characteristics	Gravel, sand and mud substrate provides habitat for suitably adapted macro-invertebrates. The muddy substrate potentially allows for some sensitive taxa to be supported at the site.	NA	NA
IHAS General Stream Characteristics	A fairly shallow pool consisting of a mix of habitats at the time of assessment. The water in the system was clear at the time of assessment. Riparian vegetation consists mostly of grasses	NA	NA

2.16.4 Aquatic Macro-Invertebrates

At present, SW 1B can be considered as a Class F (Critically impaired) site according to the Dickens and Graham (2001) classification system.

According to the Dallas (2007) classification system the site can be considered to a Class E/F (Critically Impaired).

When compared to the oldest available the April 2012 SASS5 score has increased by 3.2X at the SW 1B site and by 2.2X at the SW 2B site since 2002. The SW 2B site has decreased by 11.6% since the 2005 assessment.

The IHAS score has increased by 3.0% at the SW 1B site, and by 40.0% at the SW 2B site since the 2002 assessment. The IHAS score has increased by 12.2% at the SW 2A site since the 2005 assessment.

The ASPT score has decreased by 32.0% at the SW 1B site, and by 28.8% at the SW 2B site since the 2002 assessment. SW 2A has decreased by 19.8% since the 2005 assessment.

Based on the available habitat conditions with special mention of the lack of flow and the lack of marginal vegetation, the aquatic macro-invertebrate community in the system can be regarded as having low sensitivity and diversity.

The impoundments on the system are leading to impacts on instream flow downstream of the dam which will have a significant impact on the receiving environment downstream of the dams since these areas of the system dry out in the low flow season.

With the aquatic ecosystem indicating impaired conditions, measures to prevent further impact on the system should be taken. Special mention is made of the need to control dirty water and prevent it entering the clean water environment and measures to improve instream flow should be sought.

2.16.5 Fish Community Integrity

The table below presents the results for the application of the Fish Assemblage Integrity Index to the sites along the Elands River.

Table 2.16.5 (a): A summary of the Results obtained from the application of the FAII Index to the Site

Type of Result	Cumulative
Species present and number of individuals obtained	*Clarius grapinus*
Health and Condition	No impairment of fish health observed.
Expected FAII Score	124
Observed FAII Score	6
Relative FAII Score	4.8%
FAII Classification (Kleynhans, 1999)	Class F (Critically modified)

Impacts on the fish community in the greater catchment are likely to have led to reduction in fish community integrity of the Matlopyane Spruit.

Activities at the GMBS complex are unlikely to contribute significantly to the seriously reduced fish populations observed in this stream at the time of the assessment, but rather catchment wide impacts in the form of road crossings and weirs interrupting migration routes are the likely cause.

Ongoing monitoring of these populations should take place to identify any seasonal trends and any impacts that may emerge on this section of the Matlopyane Spruit.

2.16.6 Toxicity Testing

Table2.16.6 (a): Summary of the Toxicity Testing Results obtained on Water Samples from the Study Area

Site	*Vibrio fischeri* (% - Inhibition or + stimulation)	*Daphnia pulex* (% mortality)	*Poecilia reticulata* (% mortality)	*Selenastrum capricornutum* (% inhibition or stimulation)	Toxicological classification
SW 1B	-69	10	0	+1	Class 3: Acute Hazard
SWD	-96	90	60	-76	Class 3: Acute Hazard
BH 5	-77	70	40	+113	Class 3: Acute Hazard

In the current assessment bacterial growth inhibition tests on *Vibrio fischeri* indicated significant inhibition when tested in the laboratory for all three sites. Bacterial growth is highly inhibited by SW 1B, SWD and BH 5 and conditions in these systems can be defined as being Acutely Hazardous.

The mortality rate in the *Daphina pulex* test was 10% mortality which indicates that some impact on aquatic macro-invertebrates prior to the impacts of the GMBS facility are taking place at SW 1B. *Daphnia pulex* show a high mortality rate of 90% and 70%, indicating an increased level of toxicological response at the SWD and BH 5 facilities. This indicates an Acute Hazard (Class 3) toxicity classification for the SWD and BH 5 sites. 0% mortality levels were observed on the guppy, *Poecilia reticulata* tests undertaken on the water sample at site SW 1B while for the SWD and BH 5 facilities; a significant mortality rate of 60% and 40% is observed respectively.

The SWD tested high for *Selenastrum capricorntum* inhibition and may pose a threat when released into the receiving environment, while BH 5 show significant stimulation of *Selenastrum capricorntum* and may lead to eutrophication of the water system if released

Measures to prevent contamination of water in the receiving environment should take place to ensure that further stress on the system which already shows signs of stress prior to impact from the GMBS is prevented. Strict measures to control the level of the SW 1B, SWD and BH 5 must be implemented and strictly monitored to ensure that no spills can occur and that seepage of water with impaired quality is limited.

2.17 AIR QUALITY BASELINE

EnviroNgaka CC was contracted by Glencore Merafe Boshoek Mine and Smelter (GMBS) to compile an Atmospheric Impact Report for their operations at Boshoek. Extracts from the executive summary of this study is given in this section. Please refer to **APPENDIX 2.17 (A)** for the comprehensive Specialist Report.

2.17.1 Project Background

GMBS produces ferrochrome, and presently operates the Boshoek Smelter Complex about 21 km northwest of Rustenburg in the Northwest Province. The company also operates an opencast mining operation to the east of the smelter complex. Figure 2.17.1 (a) will show the location of the premises in relation to surrounding communities and industrial activities. *(The "Site of Works "includes all areas containing activities contributing to atmospheric emissions at the Smelter complex and the Mining area).*

The existing smelter complex is surrounded by communities i.e. Mafenya, Chaneng, Rasimone, Robega, Luka, Phokeng and several Boshoek farms. Industries around the Boshoek operation include Royal Bafokeng Platinum Mine (RBPM) and Impala Platinum mine.

The opencast mining operation extends from the Bafokeng Chrome Holdings Boshoek mine site in a southerly direction for approximately 6 km. The average mining rate is 40 000 tonnes per month. Two mining companies, Benhaus and Andru, are currently performing the mining activities on behalf of the company. Each company produces approximately 20 000 tonnes of ROM ore per month, and combined produces approximately 480 000 tonnes of run of mine (ROM) ore per year. The mined ore is currently being trucked to an offsite concentrator.

The Boshoek smelter produces ferrochrome. The existing Smelter Complex consist of a smelter plant (two 54 MVA closed submerged arc furnaces), sinter plant, raw materials storage and handling area, slurry disposal area, storm water control infrastructure and run-off dam, dirty water dam, process water dam, temporary waste storage facility, provision for railway siding, power supply facility, workshops, stores, chrome recovery plant, jig plant and an administration complex.

Due to insufficient ambient air monitoring results for January 2010 to December 2010 from the Boshoek monitoring station, the baseline period was changed from 2010 to 2009 to serve as the baseline scenario for the study. In order to cater for current production conditions (and changes identified in product formulations between 2009 and 2010), we are also evaluating additional scenarios based on expected emissions (with due consideration of the sampling results) for the operations operating at its full design capacity in order to assist with the impact assessment for the potential expansions and the future AEL conversion, etc.

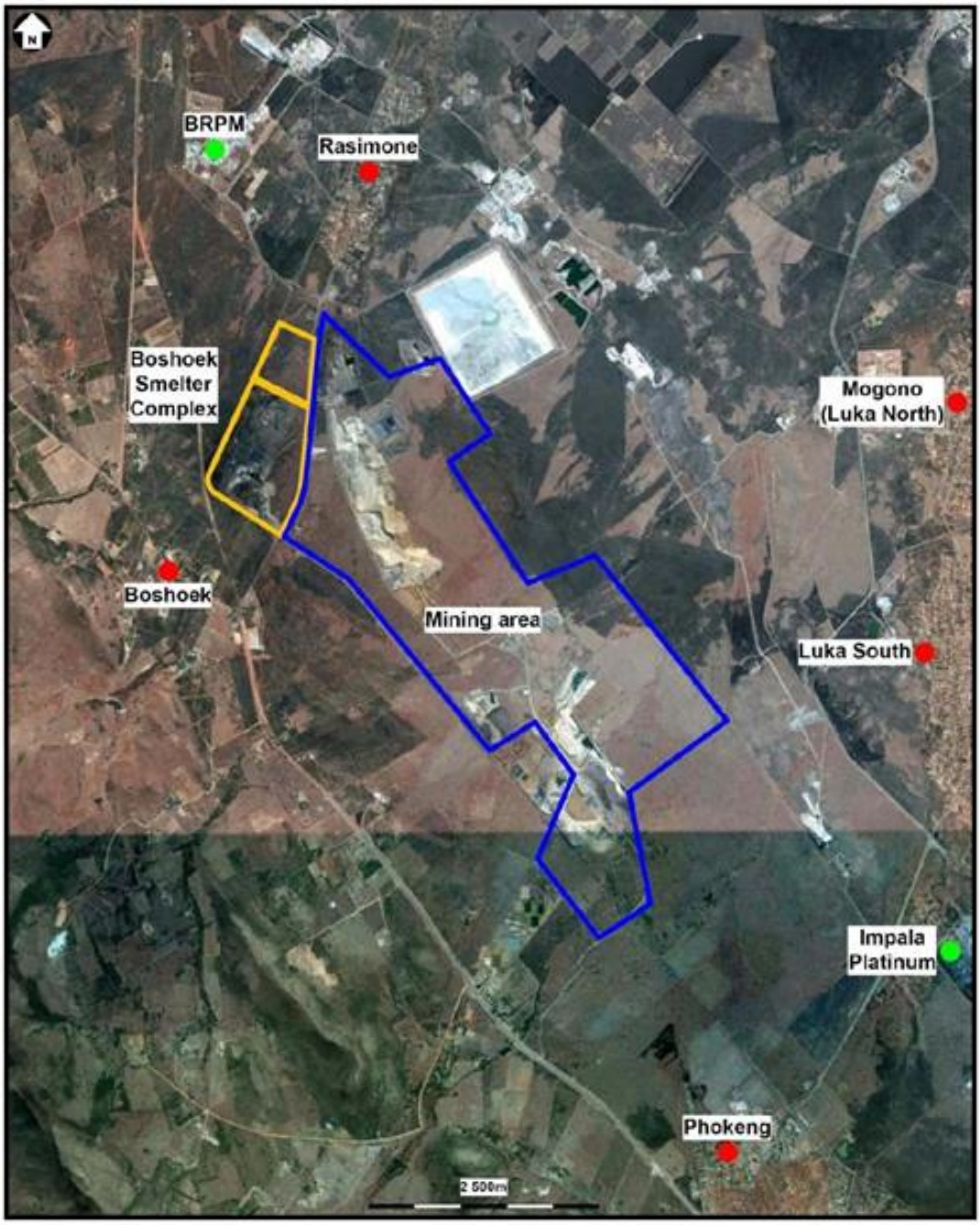

Figure 2.17.1 (a): **Satellite Image detailing Location of Premises in relation to Surrounding Communities**

2.17.2 Ambient Air Quality

Ambient air Sulphur dioxide (SO_2) and Particulate matter (PM_{10}) measurements were obtained from the Boshoek ambient air monitoring station located approximately 4 km northeast of the smelter complex (refer Figure 2.17.2 (a)).

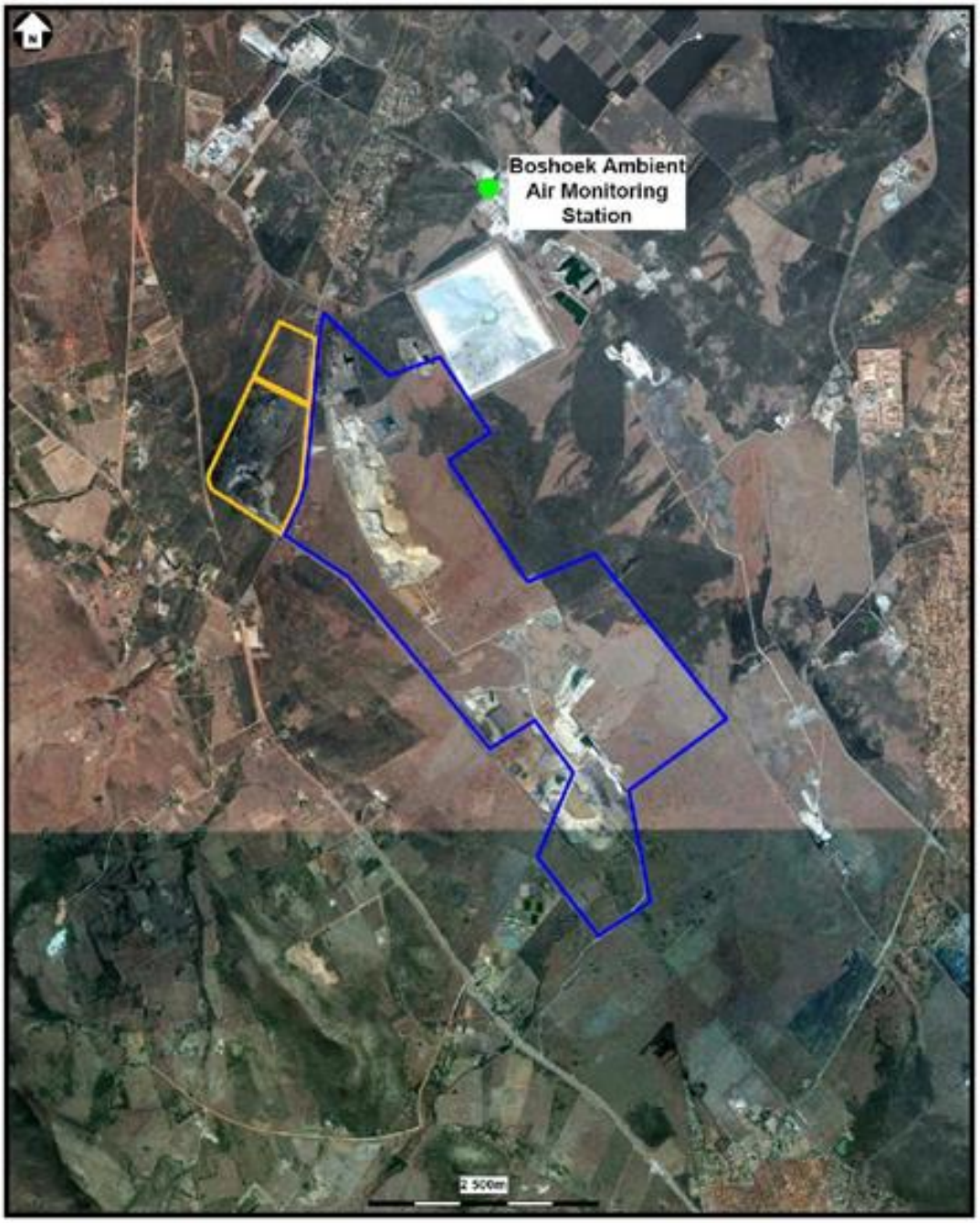

Figure 2.17.2 (a): **Location of the Boshoek Monitoring Station relative to the Site of Works**

2.17.2.1 Sulphur Dioxide (SO2)

The following is a summary of SO_2 measurements at the Boshoek monitoring station (MS) for the period January 2008 to July 2011:

SO_2 – Ambient Air Monitoring Results					
Ambient Air Monitoring Station: Boshoek MS					
Year		**2008**	**2009**	**2010**	**2011 (to July)**
Ambient air standard					
1 hour	µg/m3	350	350	350	350
24 hour	µg/m3	125	125	125	125
Annual	µg/m3	50	50	50	50
99th percentile concentration					
1 hour	µg/m3	386.10	161.85	Not available	194.09
24 hour	µg/m3	196.60	110.68	Not available	77.32
Average concentrations					
Annual (1 hr annual average)	µg/m3	37.33	19.86	Not available	17.93 (to July 2011)
Exceedences					
1 hour		101	6	Not available	9
24 hour		9	2	Not available	Not available
Annual		0	0	Not available	0
Tolerated Frequency of Exceedence					
1 hour		88	88	88	88
24 hour		4	4	4	4
Annual		0	0	0	0
Compliance					
1 hour		No	Comply	Not available	Comply
24 hour		No	Comply	Not available	Not available
Annual		Comply	Comply	Not available	Comply
Expected % of SO_2 measured, which potentially originate from the direction of the Site of Works					
1 hour		58.10%	57.75%	Not available	60.63%
24 hour		79.68%	77.74%	Not available	76.64%
Exceedences expected to potentially originate from the direction of the Site Of Works					
1 hour		40	4	0	5
24 hour		9	1	0	0
Percent of total exceedences					
1 hour		39.60%	66.67%	Not available	55.56%
24 hour		100.00%	50.00%	Not available	0.00%

The measurements at the station indicates that over the past four years (January 2008 to July 2011) on average 58.83% of measured hourly SO_2 concentrations and as much as 78.02% of 24 hour concentrations were expected to have potentially originated from the direction of the Site of Works.

The following observations are relevant:

- SO_2 measurements at this station exceeded the tolerated frequency of exceedences during 2008 for both the 1 hour and 24 hour periods.
- During 2008 it is expected that almost 40% of the 1 hour exceedences (40 of the 101) and all of the 24 hour exceedences (9 in total) are expected to have originated from the Site of Works;
- For 2009 it is expected that 66.67% of the 1 hour exceedences (4 of the 6) and 50% of the 24 hour exceedences (1 of 2) are expected to have originated from the direction of the Site of Works;
- During 2010 no SO_2 measurements were taken;
- For the year 2011, until July 2011, 9 exceedences of the 1 hour ambient air standard have already been recorded, with an expected 55.56% (5 of the 9) of the exceedences potentially originating from the direction of the Site of Works.

2.17.2.2 Particulate Matter (PM10)

The following is a summary of PM_{10} measurements at the Boshoek monitoring station (MS) for the period January 2008 to July 2011:

PM10 – Ambient air monitoring results					
Ambient air monitoring station: Boshoek MS					
	Year	2008	2009	2010	2011 (to July)
Ambient air standard					
24 hour	µg/m3	75	75	75	75
Annual	µg/m3	40	40	40	40
99th percentile concentration					
24 hour	µg/m3	130.03	116.48	Not available	106.67
Average concentrations					
Annual (1 hr annual average)	µg/m3	44.72	42.52	Not available	45.79 (to July 2011)
Exceedences					
24 hour		33	22	Not available	8
Annual		1	1	Not available	1
Tolerated Frequency of Exceedence					
24 hour		4	4	4	4
Annual		0	0	0	0
Compliance					
24 hour		No	No	Not available	No
Annual		No	No	Not available	No
Expected % of PM10 measured, which potentially originate from the direction of the Site of Works					
24 hour		70.27%	79.09%	Not available	94.83%
Exceedences expected to potentially originate from the direction of the Site Of Works					
24 hour		28	20	0	7
Percent of total exceedences					
24 hour		84.85%	90.91%	Not available	87.50%

It should be noted that the location of the station is directly north of a large tailings storage facility, located between the monitoring station and the Site of Works. The monitoring station is also neighbouring other heavy mining activities to the north and east of the station.

These activities and storage facilities is expected to contribute more significantly to ambient air PM10 concentrations measured at the monitoring station, than the expected contribution from the Site of Works.

Ambient air PM_{10} concentrations measured at the monitoring station from January 2008 to July 2011 never complied with the tolerated number of exceedences for either the 24 hour ambient air standard of 75 µg/m^3 or the annual (1 year) ambient air standard of 40 µg/m^3.

It is expected that on average 81.40% of measured PM_{10} data at the station over the past four years is expected to have potentially originated from the direction of the Site of Works. But as stated earlier, the presence of a large tailings storage facility to the east of the monitoring station is expected to have impacted negatively on the ambient air PM10 concentrations measured at this location.

It is however expected that for the total number of exceedences, the following percent of the exceedences are expected to have potentially originated from the direction of the Site of Works:

For 2008: 84.85% (28 of the 33) of the exceedences;
For 2009: 90.91% (20 of the 22) of the exceedences;
For 2010: No measurement data available;
For 2011: 87.50% (7 of the 8) of the exceedences;

2.17.2.3 Dust Deposition Monitoring

Dustfall (DFO) monitoring at GMBS began in October 2004. Currently the DFO monitoring is performed by the Ambient Division of SGS Environmental. DFO monitoring is also conducted at the Benhaus and Andru Mining operations, but it is however unclear when DFO monitoring activities started at the different locations at the mining operations.

All the DFO locations at the Site of Works are located within the boundaries of the enterprise. According to SANS 1929:2005, DFO monitors may be located within the boundaries of the industrial plant (Onsite) as defined by the legal, fenced boundaries of the enterprise, for industrial control purposes. It should be noted that even when results from these sites may be included in general environmental reports, these onsite monitors will not be evaluated against the dust deposition evaluation criteria stipulated in SANS (See Specialist Report; Section 4.8.2 Table 4.3 for the criteria) (SANS 1929:2005). DFO monitors located close to the boundaries were assumed "Fence-line" monitoring locations, and results were assessed against the guidelines.

Table 2.17.2.3 (a) will list the Smelter Complex dustfall monitoring localities. The Table will show the assumptions with regards to the different classifications used for this study. Figure 2.17.2.3 (a) will show the locations of the dust deposition monitoring equipment. Locations marked as red is located well away of the closest boundary, while locations in green were assumed close enough to the boundary of the enterprise to be assumed valid fence-line monitoring locations.

Table 2.17.2.3 (a): Glencore Merafe Boshoek Mine and Smelter Dustfall Monitoring Localities

Xstrata Boshoek: Smelter complex dustfall monitoring network							
Number allocated	Site description	Site classification	Site location	Direction from centre of Site of Works	Results available for the study	Status	Reason
1	H Sec Offices	Residential	Onsite	South	From 24 October 2007 to 20 September 2011	In use	Internal dust control
2	GCS 3 Borehole sampling point	Industrial	Onsite	East	From 24 October 2007 to 20 September 2011	In use	SANS1929 - Fenceline monitoring
3	Secondary crushing plant	Industrial	Onsite	South	From 24 October 2007 to 20 September 2011	In use	Internal dust control
4	Final product storage area	Industrial	Fenceline	West	From 24 October 2007 to 20 September 2011	In use	SANS1929 - Fenceline monitoring
5	Sintering plant	Industrial	Fenceline	West	From 24 October 2007 to 20 September 2011	In use	SANS1929 - Fenceline monitoring
6	Stock pile raw materials	Industrial	Onsite	North	From 24 October 2007 to 20 September 2011	In use	Internal dust control
7	Recovery plant	Industrial	Onsite	North	From 24 October 2007 to 20 September 2011	In use	Internal dust control
8	Old east gate entrance	Industrial	Fenceline	North	From 24 October 2007 to 20 September 2011	In use	SANS1929 - Fenceline monitoring
9	Slag bay S2	Industrial	Onsite	East	From 24 October 2007 to 20 September 2011	In use	Internal dust control
10	XSTRA 03 W	Industrial	Onsite	East	From 17 July 2009 to 20 September 2011	In use	Internal dust control
11	XSTRA 03 E	Industrial	Onsite	South	From 17 July 2009 to 20 September 2011	In use	Internal dust control
12	XSTRA 03 S	Industrial	Onsite	South	From 17 July 2009 to 20 September 2011	In use	Internal dust control
13	X-tra 11	Industrial	Fenceline	South	From 17 July 2009 to 20 September 2011	In use	SANS1929 - Fenceline monitoring
14	X-tra 10 (Security Offices)	Industrial	Fenceline	South	From 17 July 2009 to 20 September 2011	In use	SANS1929 - Fenceline monitoring
15	Storm water area	Industrial	Fenceline	North	From 18 August 2009 to 20 September 2011	In use	SANS1929 - Fenceline monitoring
16	Down stream sampling	Industrial	Fenceline	East	From 18 August 2009 to 20 September 2011	In use	SANS1929 - Fenceline monitoring
17	Adjacent Sinter mobile screen	Industrial	Fenceline	West	From 18 August 2009 to 14 July 2010	Historical	SANS1929 - Fenceline monitoring
18	Mobile screen 01	Industrial	Onsite	West	From 14 December 2009 to 14 July 2010	Historical	Internal dust control
19	Mobile screen 02	Industrial	Fenceline	West	From 14 December 2009 to 14 July 2010	Historical	SANS1929 - Fenceline monitoring
20	Silo 01	Industrial	Onsite	West	From 14 December 2009 to 14 July 2010	Historical	Internal dust control
21	Silo 02	Industrial	Fenceline	North	From 14 December 2009 to 14 July 2010	Historical	SANS1929 - Fenceline monitoring
22	Silo 03	Industrial	Fenceline	North	From 14 December 2009 to 14 July 2010	Historical	SANS1929 - Fenceline monitoring
23	Silo 04	Industrial	Onsite	North	From 14 December 2009	Historical	Internal dust control

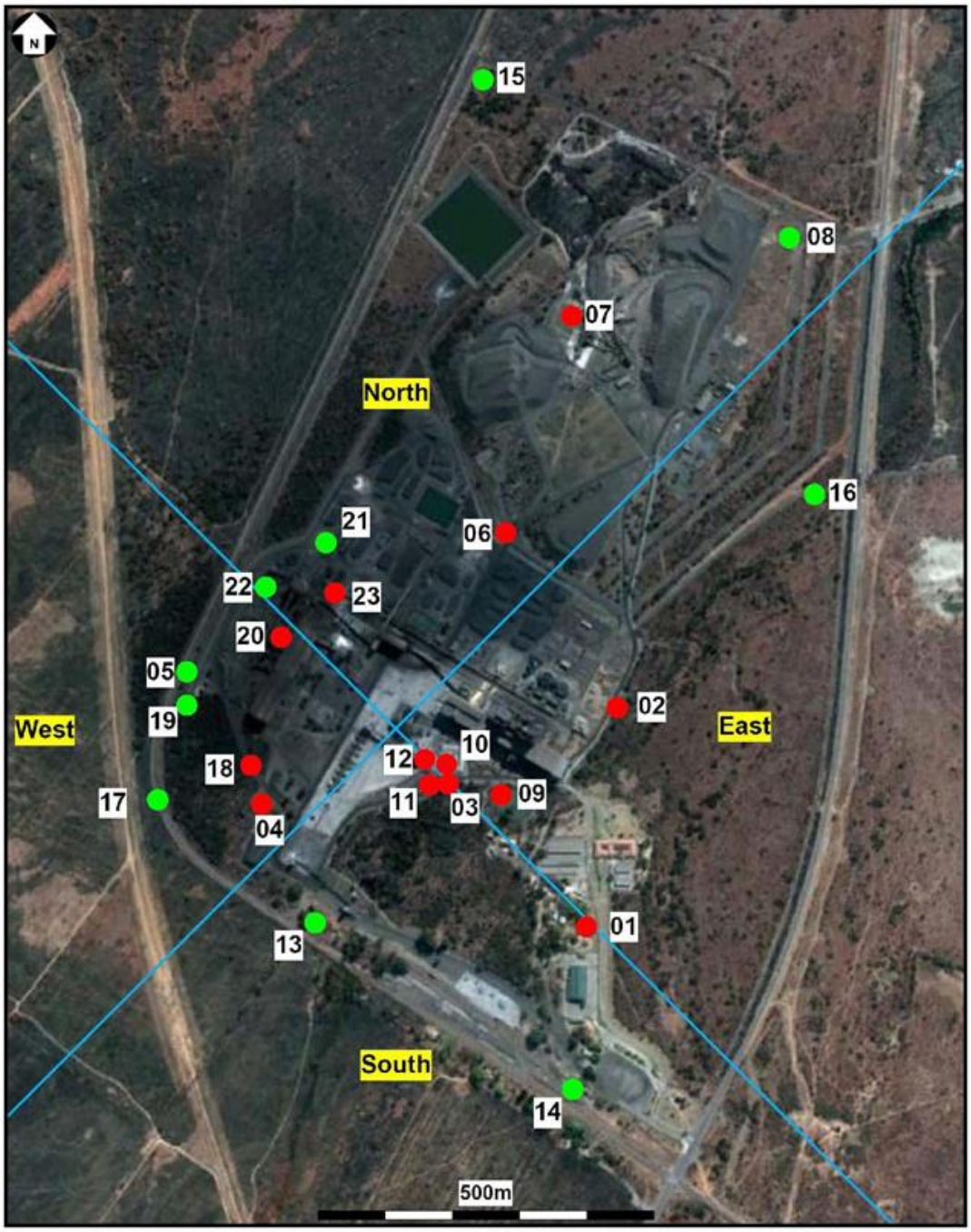

Figure 2.17.2.3 (a): **GMBS Dust Deposition Monitoring Locations**

DFO Monitoring to the North

- Four DFO locations are located close the boundary to the north of the centre of the Site of Works;
- Three DFO locations to the north of the centre of the Site of Works are considered "onsite" locations, and the results thereof were not evaluated;
- The fence-line DFO monitoring equipment to the north are the following (with the number of DFO rates recorded also reported):
  - Old east gate entrance (No. 8) with 47 DFO rates reported;
  - Storm water area (No. 15) with 24 DFO rates reported;
  - Silo 02 (No. 21) with 6 DFO rates reported;
  - Silo 03 (No. 22) with 7 DFO rates reported;

- The Industrial DFO guideline of 1 200 mg/m2/day was only exceeded at two locations, which were:
  - Silo 02 (No. 21); and
  - Silo 03 (No. 22);
- The Industrial DFO guideline of 1 200 mg/m2/day was exceeded for consecutive periods at:
  - The "Silo 02" (No. 21) location from the January 2010 to March 2010 sampling periods;
  - The "Silo 03" (No. 22) location for the January 2010 to February 2010 sampling periods;
  - The above two locations have however only been used respectively for 6 and 7 monthly sampling campaigns, after which they were decommissioned;
- The Alert threshold of 2 400 mg/m2/day was only exceeded at one location:
  - Silo 02 (No. 21)
- Results for the two DFO monitoring equipment still in use ("Old east gate entrance" (No. 8) and "Storm water area" (No. 15)), never exceeded the Action: Industrial threshold of 1 200 mg/m2/day;
- With regards to the annual average DFO rate (refer Figure 2.17.2.3 (b)):
  - Only two of the four locations, "Old east gate entrance" (No. 8) and "Storm water area" (No. 15), had more than 12 reported DFO rates;
  - Historical DFO rates at the "Old east gate entrance" (No. 8) location initially had an average annual DFO rate higher than the Target DFO rate of 300 mg/m^2/day, but since the March 2009 sampling period the annual average DFO rate at this location was below the Target DFO rate;
  - Overall, the two locations shows that the DFO rates reported have been consistently decreasing from November 2007 to September 2011;

DFO Monitoring to the East

- Only one DFO location, "Downstream sampling" (No. 16), is located close the boundary to the east of the centre of the Site of Works;
- Three DFO locations to the east of the centre of the Site of Works are considered "onsite" locations, and the results thereof were not evaluated;
- The table indicates that the "Action: Industrial" DFO guideline of 1 200 mg/m2/day have not been exceeded at the "Downstream sampling" (No. 16) location since monitoring exercises started there during the September 2009 sampling period;
- With regards to the annual average DFO rate (refer Figure 2.17.2.3 (b)):
  - For the running annual average of the fence-line DFO monitoring at this location, the annual average DFO rate never exceeded the 300 mg/m^2/day Target level.

DFO Monitoring to the South

- Two DFO locations are located close the boundary to the south of the centre of the Site of Works;
- Four DFO locations to the south of the centre of the Site of Works are considered "onsite" locations, and the results thereof were not evaluated;
- The fence-line DFO monitoring equipment to the south are the following (with the number of DFO rates recorded also reported):
  - X-tra 11 (No. 13) with 26 DFO rates reported;
  - X-tra 10 (Security Offices) (No. 14) with 26 DFO rates reported;
- The Alert threshold of 2 400 mg/m2/day was never exceeded at these locations;
- The "Action: Industrial" DFO guideline of 1 200 mg/m2/day was only exceeded twice, and was only exceeded at the "X-tra 11" (No. 13) location, for consecutive periods during the October 2009 and November 2009 sampling periods;
- With regards to the annual average DFO rate (refer Figure 2.17.2.3 (b)):
  - Historical DFO rates at the "X-tra 11" (No. 13) location never achieved an average annual DFO rate lower than the Target DFO rate of 300 mg/m2/day;
    - It should be noted however that since the July 2010 sampling period the annual average DFO rate at this location reduced from the initial high DFO rates recorded during the October 2009 and November 2009 sampling periods;
  - The annual average DFO rates at the "X-tra 10" (Security Offices) (No. 14) location are below the Target level of 300 mg/m2/day;

DFO Monitoring to the West

- Three DFO locations are located close the boundary to the west of the centre of the Site of Works;
- Three DFO locations to the west of the centre of the Site of Works are considered "onsite" locations, and the results thereof were not evaluated;
- The fence-line DFO monitoring equipment to the west are the following (with the number of DFO rates recorded also reported):
  - Sintering plant (No. 5) with 45 DFO rates reported;
  - Adjacent Sinter mobile screen (No. 17) with 11 DFO rates reported;
  - Mobile screen 02 (No. 19) with 7 DFO rates reported;
- The "Action: Industrial" DFO guideline of 1 200 mg/m2/day was exceeded at the following two locations:
  - Sintering plant (No. 5) – 24 times; and
  - Adjacent Sinter mobile screen (No. 17) – 2 times;
- The "Action: Industrial" DFO guideline of 1 200 mg/m2/day was exceeded for consecutive periods at the "Adjacent Sinter mobile screen" (No. 17) location, and the "Sintering plant" (No. 5) location;
  - One consecutive period at the "Adjacent Sinter mobile screen" (No. 17) location, and
  - For 18 consecutive periods at the "Sintering plant" (No. 5) location;
- The Alert threshold guideline of 2 400 mg/m2/day was only exceeded at the "Sintering plant" (No. 5) location. It was exceeded 5 times from November 2007 to September 2011;

- With regards to the annual average DFO rate (refer Figure 2.17.2.3 (b)):
  - Only one of the three locations, "Sintering plant" (No. 5), had more than 12 reported DFO rates which could be included in the graph;
  - Historical DFO rates at this location shows a downward trend in DFO rates, but excessively high DFO rates reported for November 2009 to May 2010 negatively impacted on this trend;
    - From June 2010 to September 2011 the annual average DFO rate again showed a downward trend;
    - The annual average DFO rate at this location never reached the Target DFO rate of 300 mg/m2/day;
  - Overall, apart from the November 2009 to May 2010 sampling periods, the DFO rates reported have shown a decrease in DFO rates from November 2007 to September 2011;

Figure 2.17.2.3 (b) will show the annual average DFO rate, as a running average, for the Fence-line monitoring locations.

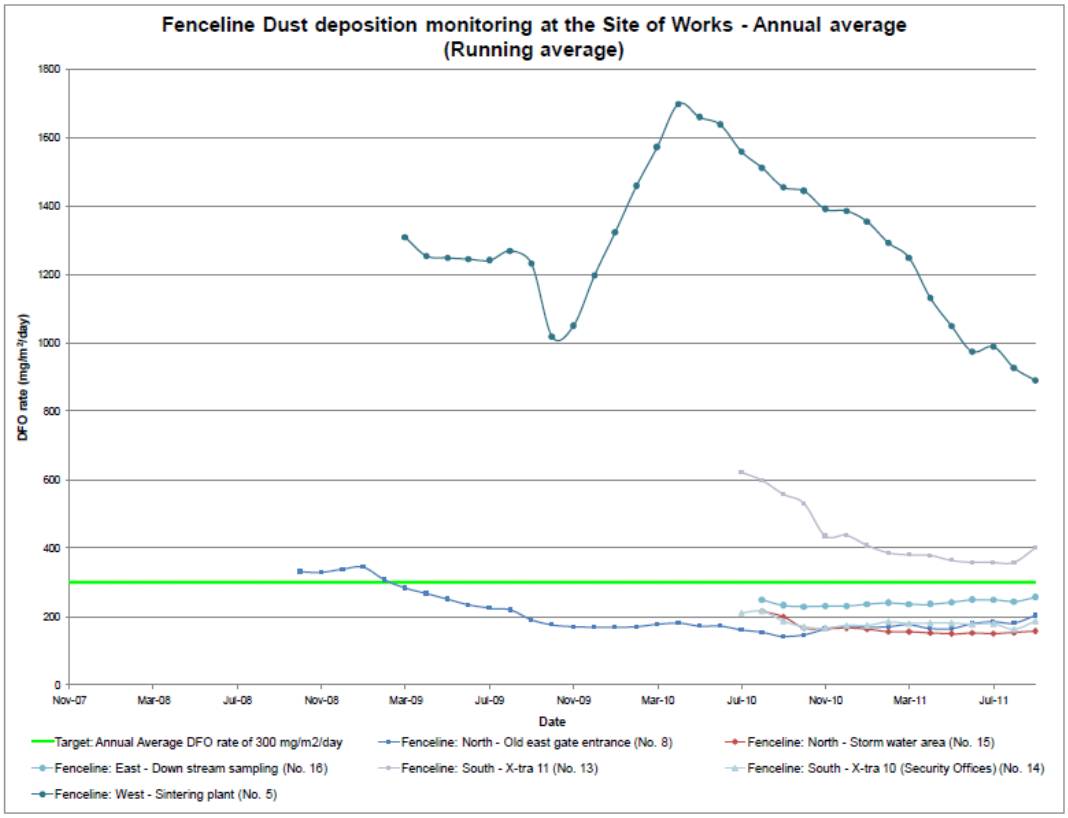

Figure 2.17.2.3 (b): **Fence-line Dust Deposition Monitoring at the Site of Works - Annual Average (running average)**

DFO Monitoring at the Andru Mining Operations

The dustfall monitoring network at Andru Mining operations is provided in Table 2.17.2.3 (b), and illustrated in Figure 2.17.2.3 (c).

Table 2.17.2.3 (b): GMBS Andru Mining Dustfall Monitoring Network

Xstrata Boshoek: Andru Mining dustfall monitoring network							
Number allocated	Site description	Site classification	Site location	Direction from centre of Site of Works	Results available for the study	Status	Reason
24	At Pink House	Industrial	Onsite	n/ap	From 09 January 2009 to 23 July 2010	In use	Internal dust control
25	Behind Pit 1	Industrial	Fenceline	n/ap	From 09 January 2009 to 23 July 2010	In use	SANS1929 - Fenceline monitoring
26	At security gate	Industrial	Fenceline	n/ap	From 09 January 2009 to 23 July 2010	In use	SANS1929 - Fenceline monitoring
27	Next to Haul Road	Industrial	Onsite	n/ap	From 09 January 2009 to 23 July 2010	In use	Internal dust control

Figure 2.17.2.3 (c): Andru Mining Area Dust Deposition Monitoring Locations

Two DFO locations are located close the boundary to the Andru mining area, while two DFO locations at the mining operations are considered "onsite" locations, and the results thereof were not evaluated.

- The fence-line DFO monitoring equipment are the following (with the number of DFO rates recorded also reported):
  - Behind Pit 1 (No. 25) with 16 DFO rates reported;
  - At security gate (No. 26) with 17 DFO rates reported;
- The "Action: Industrial" DFO guideline of 1 200 mg/m2/day was exceeded at the following location:
  - Behind Pit 1 (No. 25) – 1 time;
  - The "Action: Industrial" DFO guideline of 1 200 mg/m2/day was not exceeded for consecutive periods;
  - The Alert threshold guideline of 2 400 mg/m2/day was not exceeded;
  - With regards to the annual average DFO rate:
  - Historical DFO rates at this location shows a downward trend in DFO rates;
    - The annual average DFO rate for all the fence-line DFO locations are below the Target DFO rate of 300 mg/m2/day;

DFO Monitoring at the Benhaus Mining operations

The dustfall monitoring network at Benhaus Mining operations is provided in Table 2.17.2.3 (c), and illustrated in Figure 2.17.2.3 (d).

Table 2.17.2.3(c): GMBS Benhaus Mining Dustfall Monitoring Network

Xstrata Boshoek: Benhaus Mining dustfall monitoring network							
Number allocated	Site description	Site classification	Site location	Direction from centre of Site of Works	Results available for the study	Status	Reason
28	Old Slimes Dam	Industrial	Fenceline	n/ap	From 09 January 2009 to 23 July 2010	In use	SANS1929 - Fenceline monitoring
29	At Security gate	Industrial	Fenceline	n/ap	From 09 January 2009 to 23 July 2010	In use	SANS1929 - Fenceline monitoring
30	Under main power lines	Industrial	Fenceline	n/ap	From 09 January 2009 to 23 July 2010	In use	SANS1929 - Fenceline monitoring
31	Smelter Slimes Dam	Industrial	Fenceline	n/ap	From 09 January 2009 to 23 July 2010	In use	SANS1929 - Fenceline monitoring

Figure 2.17.2.3 (d): Benhaus Mining Area Dust Deposition Monitoring Locations

All four DFO locations in the Benhaus mining area are considered as located close to the boundary;

- The fence-line DFO monitoring equipment are the following (with the number of DFO rates recorded also reported):
  - Old Slimes Dam (No. 28) with 6 DFO rates reported;
  - At Security gate (No. 29) with 18 DFO rates reported;
  - Under main power lines (No. 30) with 15 DFO rates reported;
  - Smelter Slimes Dam (No. 31) with 18 DFO rates reported;
- The "Action: Industrial" DFO guideline of 1 200 mg/m2/day was not exceeded at any of the locations;
- The "Action: Industrial" DFO guideline of 1 200 mg/m2/day was not exceeded for consecutive periods;
- The Alert threshold guideline of 2 400 mg/m2/day was not exceeded;
- With regards to the annual average DFO rate:
  - Historical DFO rates at this location shows a downward trend in DFO rates;
    - The annual average DFO rate for all the fence-line DFO locations are below the Target DFO rate of 300 mg/m2/day;

2.18 NOISE BASELINE

M2 Environmental Connections was commissioned to undertake a specialist study to determine the current baseline ambient sound and noise levels in the vicinity of the existing Glencore Merafe Boshoek Mine and Smelter operation close to Rustenburg, North-west Province. This section contains a summary extract from the Specialist Base Line Report. Refer to **APPENDIX 2.18 (A)** for the comprehensive Noise Specialist Baseline Report.

2.18.1 Study Area

The site is situated in the Rustenburg Local Municipality which falls within the Bojanala District municipal area in the North-West Province. This is of critical relevance due the fact that the province has not promulgated their own provincial noise control regulations, nor have the Local Municipality adopted the Model By-laws. A site locality map is presented in Figure 2.18.1(a). The study area is further described in terms of environmental components that may contribute or change the sound character in the area.

2.18.1.1 Surrounding Land Use

The surroundings are mainly classified as vacant/unspecified (DEAT Environmental Atlas) with mining, residential and subsistence farming land-uses taking place in the area. The residential community of Rasimone are north of the area of interest. There are a number of residential and commercial activities adjacent to the busy R565.

2.18.1.2 Roads and Railway Lines

The busy Rustenburg – Sun City road (R565) passes the site approximately 1,000 meters to the west with the Boshoek/Rasimone road transecting the site just east of the GMBS smelter.

2.18.1.3 Residential Areas

The Rasimone residential community is directly north of the operation, with the closest residents of the Rankotia community approximately 1,000 meters directly east from the infrastructure in the operation.

2.18.1.4 Ground Conditions and Vegetation

During the site visit it was observed that the terrain is well vegetated. Vegetation will assist in the attenuation of noise (50% soft ground conditions will be used during sound propagation modelling).

2.18.1.5 Topography

The area is relatively flat, with little natural features that may assist with the attenuation of noise.

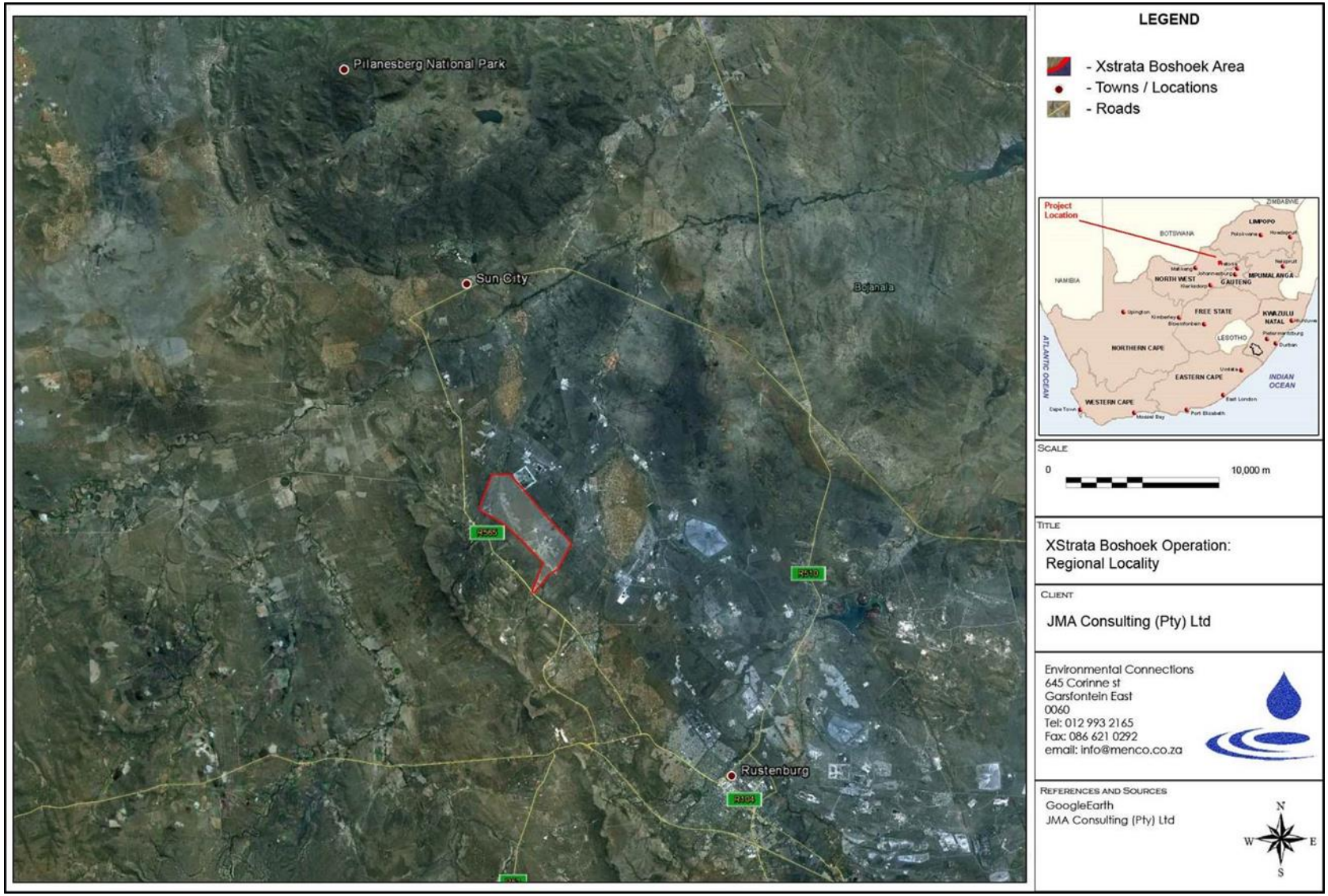

Figure 2.18.1 (a): Site Locality Map showing the GMBS Site within the Rustenburg Mining Zone

2.18.1.6 Other Noise Sources

There are a number of significant noise sources in the area, with the R565 being the most definable noise source with other noise sources including the numerous mining activities in the area.

2.18.2 Potentially Noise-Sensitive Receptors

Potentially sensitive receptors were initially identified using GoogleEarth®, supported by a site visit on 25, 26 and 27 March 2013. The reason for the site visit, apart from measuring ambient sound levels, is that there could be a number of derelict or abandoned dwellings that are not seen as a potential sensitive receptor, small dwellings that could not be identified on the aerial image, or those dwellings that were built after the date of the aerial photograph. There are a number of people living in the vicinity of this industrial complex as illustrated in Figure 2.18.2 (a)

2.18.3 Onsite Measurements – Ambient Sounds

Measurements were taken from the afternoon of 25th March 2013 to the afternoon of 27th March 2013. The sound measuring equipment was calibrated directly before, and directly after the measurements was collected. In all cases drift was less than 0.2 dBA. The locations used to measure ambient (background) sound levels are presented in Figure 2.18.3 (a).

By assessing measurement data conducted for this report, a basic estimation of the soundscape was established at these receptors. Measurements included two singular 10-minute equivalent sound levels at XASM04 as well as numerous 10-minute measurements over a period of approximately 24 hours at other locations. Unfortunately, due to technical error no data was saved at XASM01 and these measurements will be recollected during the environmental noise impact assessment stage.

Significant rainfall was observed in the area for the time period 17:00 – 22:00 (25 March 2013). Sound levels data recorded during this rainfall period was not removed but will be highlighted.

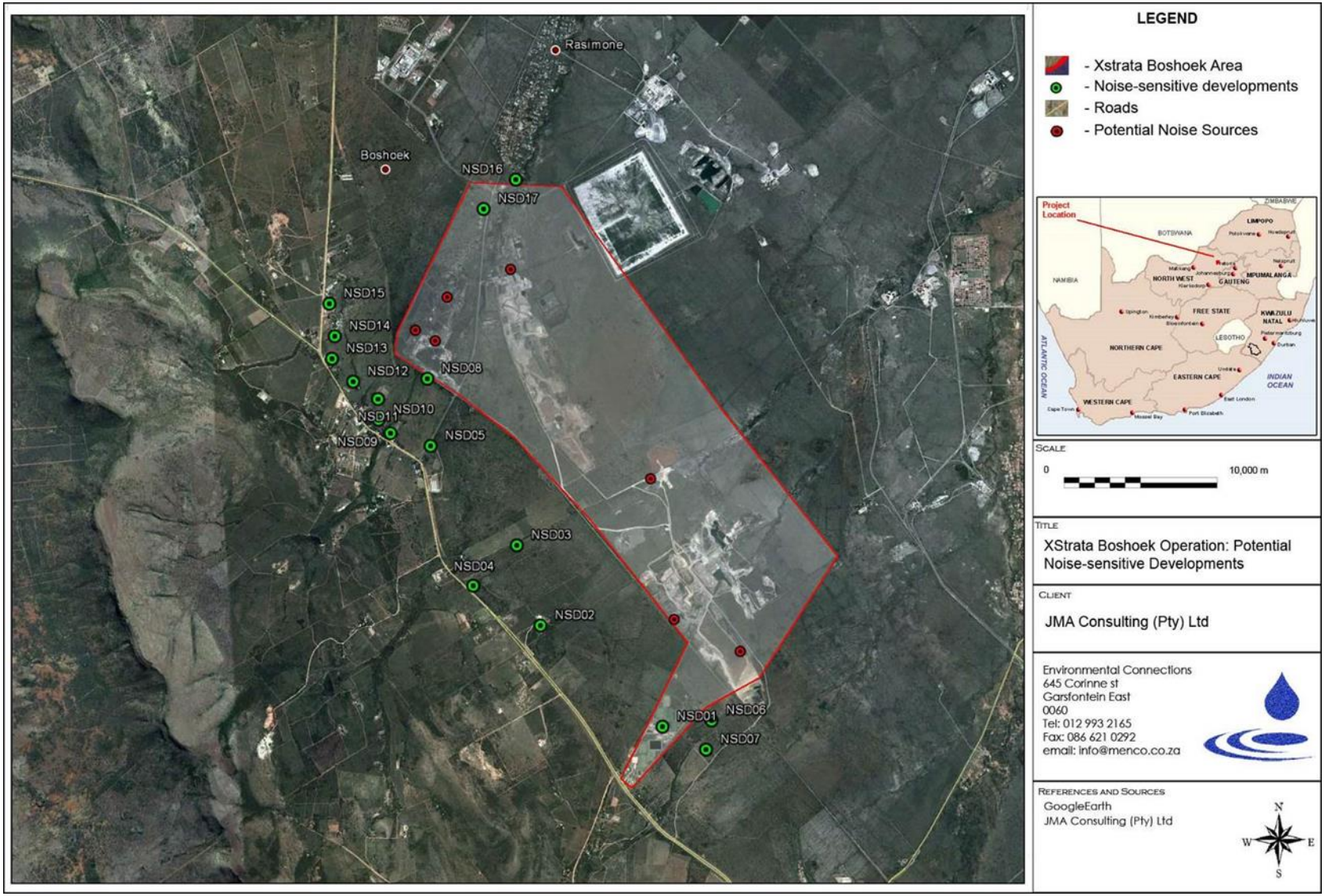

Figure 2.18.2 (a): Potentially Noise Sensitive Receptors

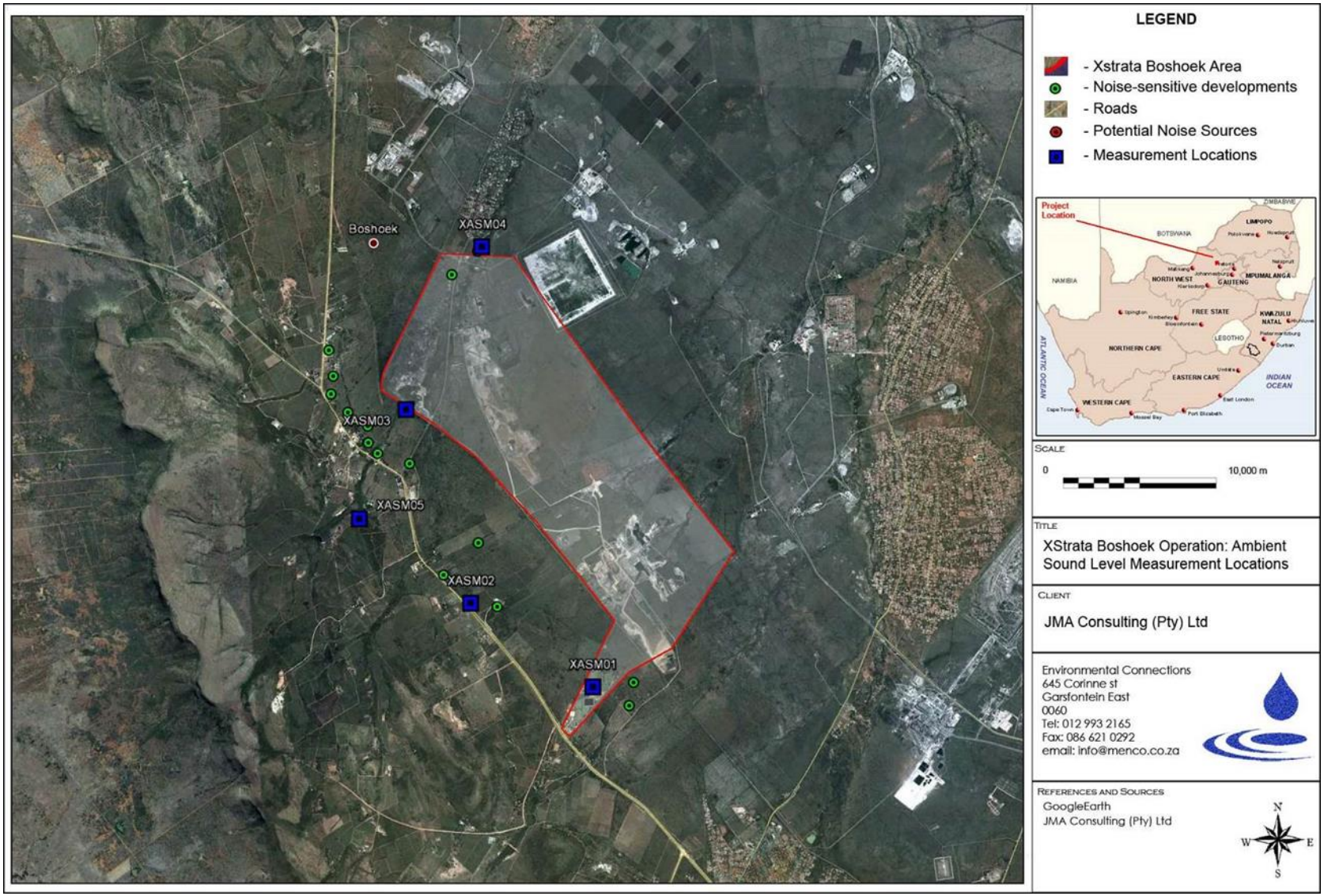

Figure 2.18.3 (a): Localities of Ambient Noise Measurements

2.18.3.1 Measurement Point XASM01 (NSD01 – Royal Marang Hotel)

This measurement location was also chosen as it was a safe area for the equipment to be left overnight. The instrument was erected in front of the hotel approximately 10 meters from the swimming pool in an area that would be used by the guests of the establishment. The instrument was at this location for ±48 hours.

Unfortunately no data was recorded due to a memory error (corrupt memory card). Measurements will be repeated during the future Environmental Noise Impact Assessment phase.

2.18.3.2 Measurement Point XASM02 (Lohat Lodge – between NSD02 and NSD04)

This measurement location is located at a Lodge situated directly adjacent to the R565. The measurement location was partly shielded from noise from the R565 in an area that would be used by the guests of the lodge.

The sound character generally consisted of traffic noise from the R565 although natural sounds were observed (bird calls and insects). Data up to 22:00 was removed due to high wind speeds, rain and thunder would have impacted on the ambient sound levels.

Measured 10-minute LAIeq day/night-time Data: During the daytime LAIeq values ranged from 32.7 to 88.6 dBA. The night-time LAIeq values (night-time reference period 22:00 – 06:00) ranged from 31.4 to 74.6 dBA. The daytime measured average was 55.9 dBA while night-time average was 50.5 dBA. Measured data reflected a noisy area with most of the noise originating from the R565 road.

Measured 10-minute LA90 day/night-time Data: LA90 is a statistical indicator that describes the noise level that is exceeded 90% of the time. Daytime values ranged from 37.5 to 59.5 dBA. The night-time LA90 values ranged from 33.7 to 53.7 dBA (night-time reference period 22:00 – 06:00). The daytime measured average was 46.8 dBA while the night-time average was 39.1 dBA. Measured LA90 data indicated that there are consistent background ambient sounds in the study area during all hours at this receptor.

LAIeq - LA90 average difference, day/night-time: The average daytime difference between the LAIeq and LA90 variables was 10.3 dBA while the night-time was 11.4 dBA. This large difference is typical of an area where impulsive sounds dominate. This likely relates to traffic on the R565.

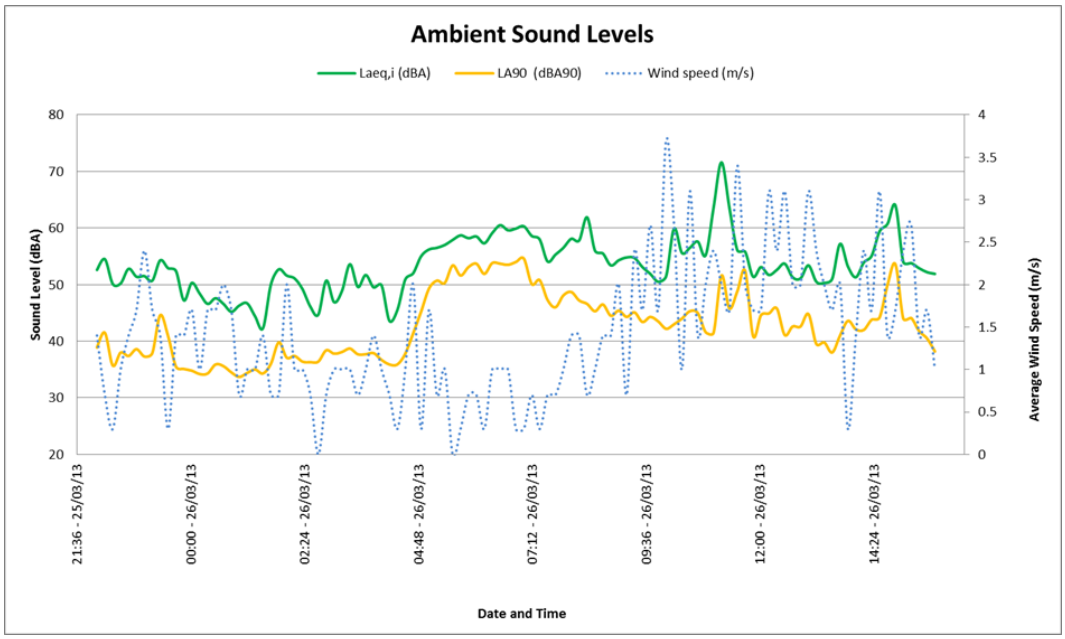

Figure 2.18.3.2 (a): Ambient Sound Levels at XASM02 (25th – 26th March)

Third Octave Spectral Analysis:

Third octaves were measured and are displayed in Figure 2.18.3.2 (b), Figure 2.18.3.2 (c), Figure 2.18.3.2 (d) and Figure 2.18.3.2 (e),

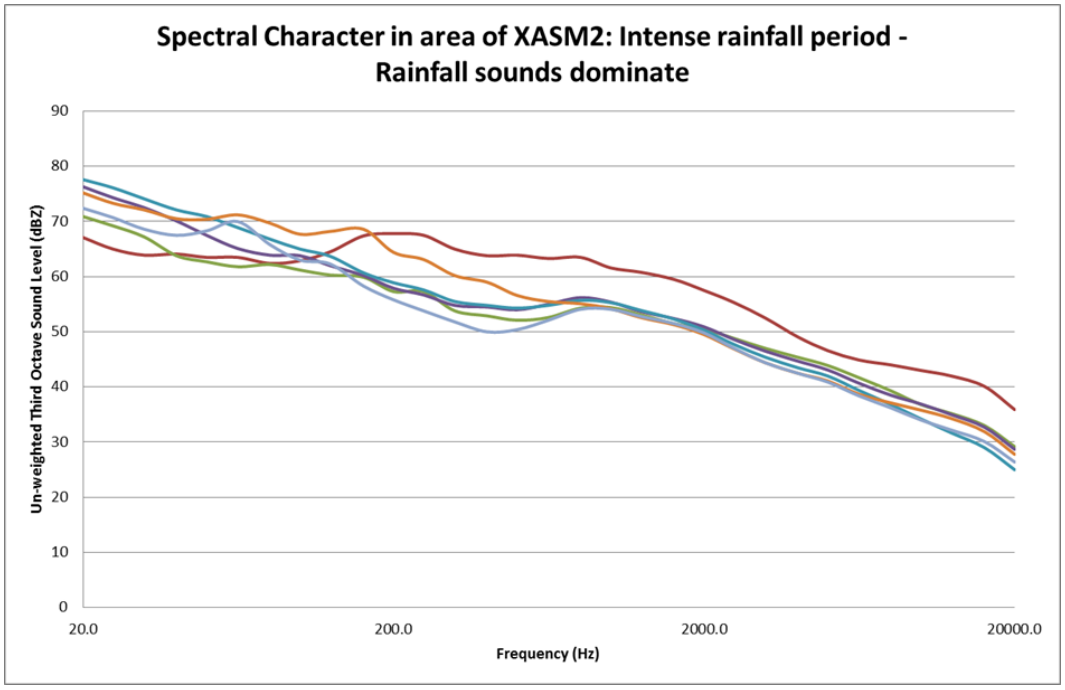

Figure 2.18.3.2 (b): Spectral Character during rainfall event: XASM02 (25th – 26th March)

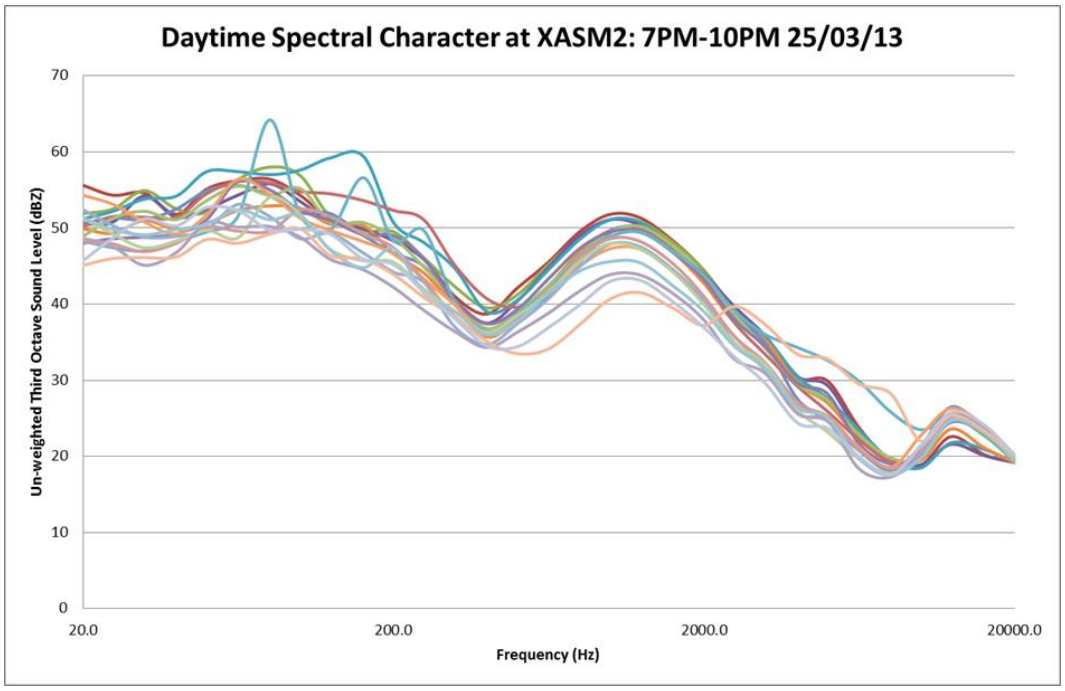

Figure 2.18.3.2 (c): Spectral Frequency Distribution as measured on-site at XASM02 - evening

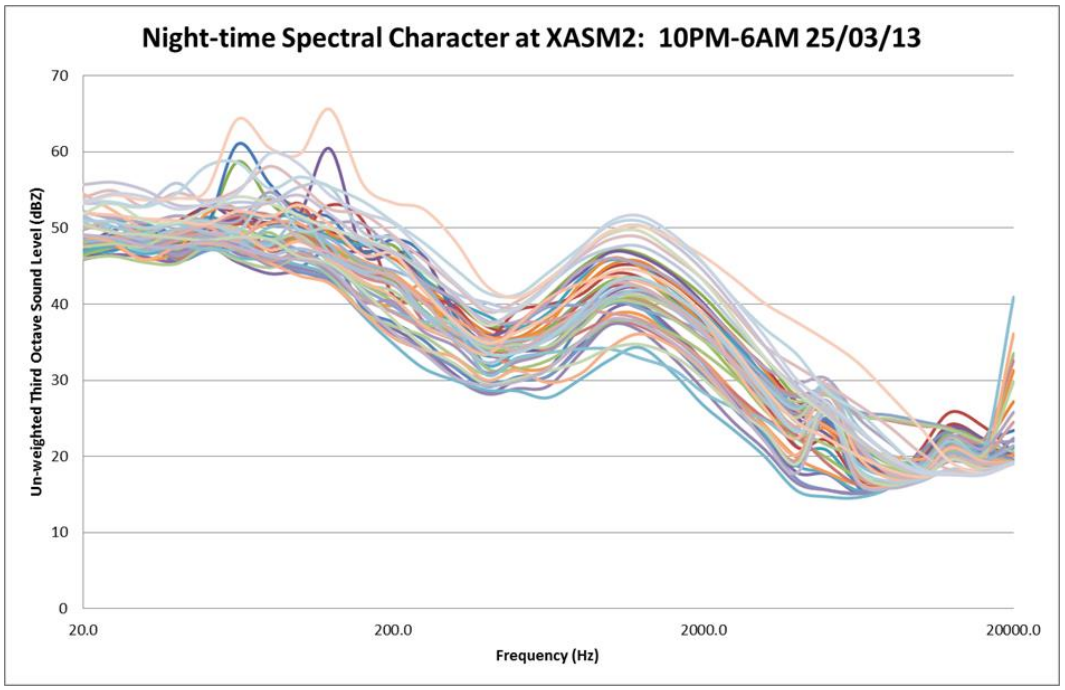

Figure 2.18.3.2 (d): Spectral Frequency Distribution as measured on-site at XASM02 – night-time

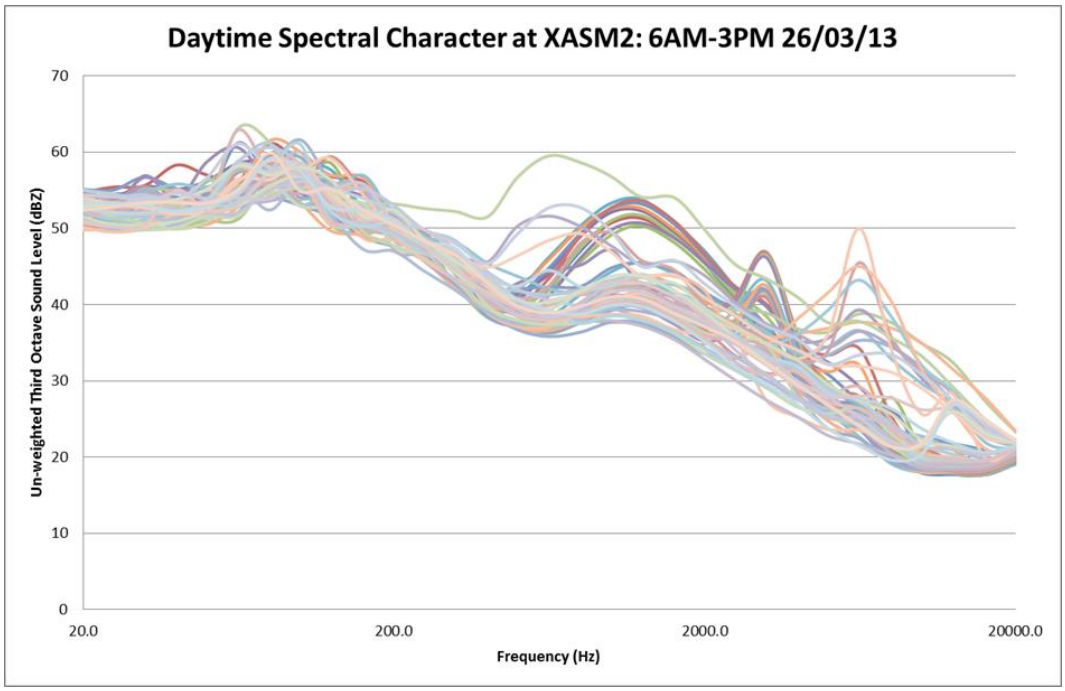

Figure 2.18.3.2 (e): Spectral Frequency Distribution as measured on-site at XASM02 – morning and day

Lower frequency (20 – 250 Hz) – Noise sources of significance in this frequency band would include nature (wind especially) and sounds of anthropogenic origin, especially vehicles. Lower frequencies can travel further through the atmosphere than higher frequencies. Most of the measurements reflect significant acoustic energy in these frequency bands, likely relating to traffic on the R565.

Third octave surrounding the 1000 Hz – This range contains energy mostly associated with human speech (350 Hz – 2500 Hz; mostly below 1,000 Hz) and dwelling noises. A fair amount of acoustic energy was measured at this range with a distinctive peak between 630 – 2,500 Hz for most measurements (both night and day). Measurements would reflect sounds from daily activities from receptors/industries as well as human communication near the sound level meter. Because this peak can be identified with most samples, including the typical quiet night-time period, it is likely that this relates to an unidentified constant noise source, potentially mining operations in the area.

Higher frequency (2,000 Hz upwards) – Smaller faunal species such as birds, crickets and cicada use this range to communicate and hunt etc. Some peaks were observed in this frequency range that could be contributed to faunal species such as bird song or cicada communications (possibly even bats at frequencies higher than 16,000 Hz).

Spectral data analysis concludes that the area has many anthropogenic activities occurring in this area mostly dominating the ambient soundscape.

LAmax night-time occurrences: Many instantaneous noise events occurred in the area during night-time measurement hours (99 events where sound levels exceeded 65 dBA out of 137 measurements). These could likely be attributed to noises on the R565. Maximum noise events may affect sleeping patterns in humans.

C-weighted (LAIeq) vs. A-weighted (LAIeq): Lower frequency was not analysed during measurement dates.

Sounds heard during measurements dates: Traffic on the R565, bird and insects. While data indicates the presence of an industrial noise it was not identified during the site visits.

SANS 10103 Rating Level: Measured data indicated a rating level of "Urban district with one or more of the following: workshop; business premises; and main roads" when considering the SANS Guideline (60/50 dBA day/night rating).

2.18.3.3 Measurement Point XASM03 – (NSD08, Railway house)

The point is at an occupied railway house situated less than 10 meters from the railway line. This house is rented from Transnet voluntary. It was reported by the occupant of this house that the railway line carries trains constantly with trains up to one an hour. The house is also close to a railway siding that is used by GMBS.

The SLM was installed at the receptor from the afternoon of 25 to the afternoon of 27 March 2013. This instrument is not fitted with a third octave filter.

Measured 10-minute LAIeq day/night-time data: During the daytime LAIeq values ranged from 37.2 to 110 dBA. The night-time LAIeq values (night-time reference period 22:00 – 06:00) ranged from 38.7 to 103.5 dBA. The daytime measured average was 58.7 dBA while night-time average was 55.8 dBA. Measured data reflected a very noisy area with most of the noise originating from the railway line (maximum noises) and activities from the railway siding.

Measured 10-minute LA90 day/night-time data: LA90 is a statistical indicator that describes the noise level that is exceeded 90% of the time. Daytime values ranged from 39.3 to 60 dBA. The night-time LA90 values ranged from 40.4 to 51.5 dBA (night-time reference period 22:00 – 06:00). The daytime measured average was 47.4 dBA while the night-time average was 45.7 dBA. Measured LA90 data indicated that there are consistent background ambient sounds in the study area during all hours at this receptor.

LAIeq - LA90 average difference, day/night-time: The average daytime difference between the LAIeq and LA90 variables was 11.3 dBA while the night-time was 10.0 dBA. This large difference is typical of an area where impulsive sounds dominate. This likely relates to noise from the railway as well as the activities at the railway siding. While sounds were audible from the smelter buildings ambient sound levels was dominated by sounds closer to the microphone location.

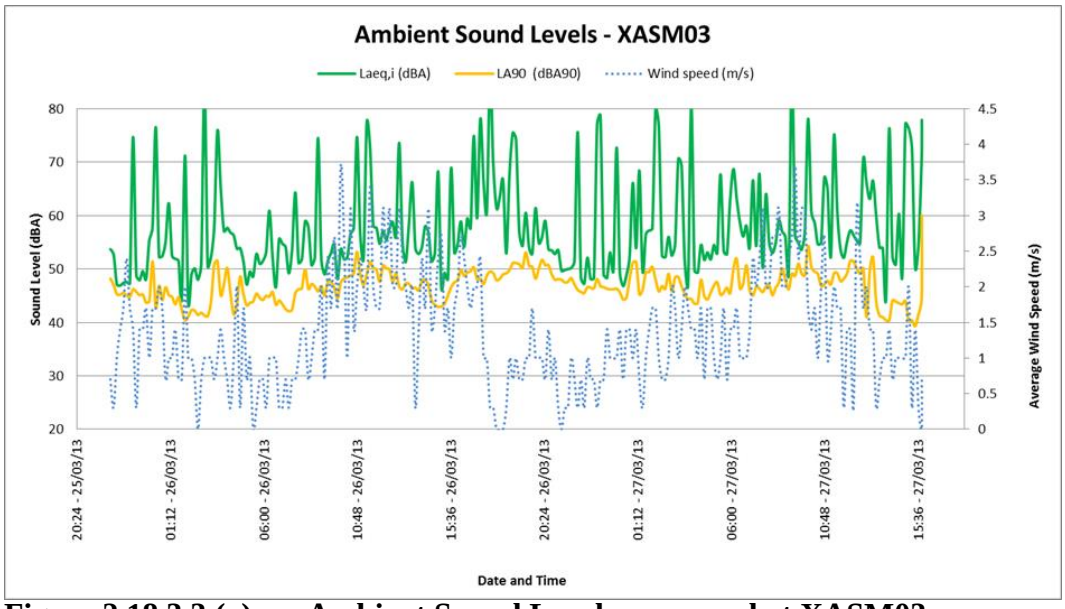

Figure 2.18.3.3 (a): Ambient Sound Levels measured at XASM03: 25 – 27 March 2013

LAmax night-time occurrences: Many instantaneous noise events occurred during the night-time measurement hours likely from the industrial activities in the area (188 events where sound levels exceeded 65 dBA out of 275 measurements). Maximum noise events may affect sleeping patterns in humans.

Sounds heard during measurements dates: Trains and activities as the siding were clearly audible at all times with noise from the train dominating during passing. Music from the residence was loud at all times the author was present. Animal sounds were also audible at times when sounds from the siding subsided. An alarm from the direction of the smelter unit was also audible.

SANS 10103 Rating Level: Measured data indicated a rating level of "Urban district with one or more of the following: workshop; business premises; and main roads" when considering the SANS Guideline (60/50 dBA day/night rating).

2.18.3.4 Measurement Point XASM04 (Close to NSD16 – Rasimone)

This location was on the edge of Rasimone at the end of a gravel road between two houses. The feasibility of leaving an instrument for a longer period was investigated but after discussions with the locals it was decided against this.

Because only one location was measured as well as the fact that only two measurements were collected this data will not be considered representing the sound climate in Rasimone. It should be noted that the author did investigate three different locations with all the locations being similar, namely:

- Loud music audible from houses dominating
- Children playing in the vicinity. Being inquisitive the measurements had to be re-started numerous times;
- Constant foot traffic in the roads;
- Voices from the area; and
- Traffic on the surrounding roads was audible at times.

Figure 2.18.3.4 (a) illustrates the spectral frequencies recorded at this location during the measurement period.

Table 2.18.3.4 (a): Results of two singular ten-minute sound level measurements (Datum type: WGS84, Decimal Degrees)

Point name	Latitude, Longitude	Time	$L_{AIeq,T}$ (dBA)	L_{A90} (dBA)	$L_{A, max}$ (dBA)	$L_{A, min}$ (dBA)	Ave. wind (m/s)
XASM04	-26.163908°, 28.689653°	16:10	65.1	52.0	82.7	40.6	2.7
		16:20	65.7	50.2	88.9	43.4	2.4

Note: SLM fitted at all times with appropriate windshield

While the residential character could be defined as "Suburban district with little road traffic" with SANS 10103:2008 rating of 50/40 dBA day/night respectively, sound levels are more reflective of a commercial area.

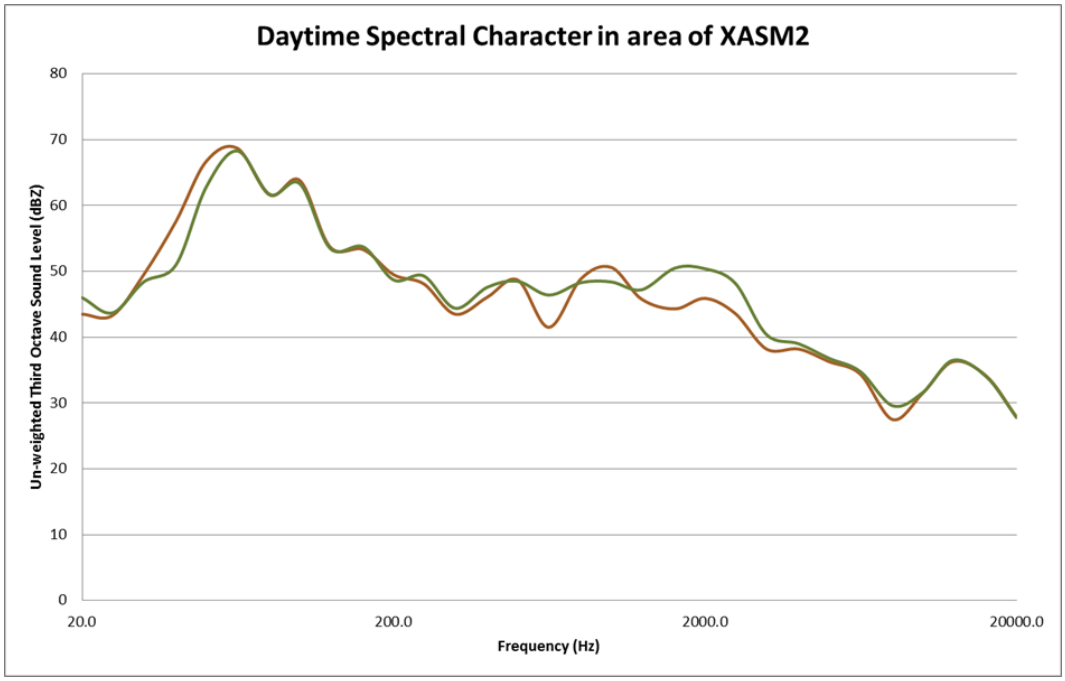

Figure 2.18.3.4 (a): Spectral Frequencies recorded at XASM04 during the measurement

2.18.3.5 Measurement Point XASM05 (Leisure Sands)

This measurement location is located at a relative quiet area away from the area that is frequented by the guests. This was mainly done for safety reasons. This site is about 800 – 900 meters from the R565 and while the road was audible at times, closer sounds would dominate the sound levels and character.

Being further from any activities sound levels were more natural with faunal (birds and insects) sounds dominating most of the times, although voices and the sounds of vehicles were observed.

Measured 10-minute LAIeq day/night-time data: During the daytime LAIeq values ranged from 30.6 to 78.7 dBA. The night-time LAIeq values (night-time reference period 22:00 – 06:00) ranged from 29.8 to 72.7 dBA. The daytime measured average was 45.4 dBA while night-time average was 42.1 dBA. Measured data reflected a relative quiet area with most sounds originating from natural sources.

Measured 10-minute LA90 day/night-time data: LA90 is a statistical indicator that describes the noise level that is exceeded 90% of the time. Daytime values ranged from 33.6 to 49.3 dBA. The night-time LA90 values ranged from 34.2 to 43 dBA (night-time reference period 22:00 – 06:00). The daytime measured average was 39.3 dBA while the night-time average was 37.3 dBA. Measured LA90 data indicated that there are consistent background ambient sounds in the study area during all hours at this receptor.

LAIeq - LA90 average difference, day/night-time: The average daytime difference between the LAIeq and LA90 variables was 6.1 dBA while the night-time was 4.8 dBA. This difference is typical of an area where natural sounds are dominant.

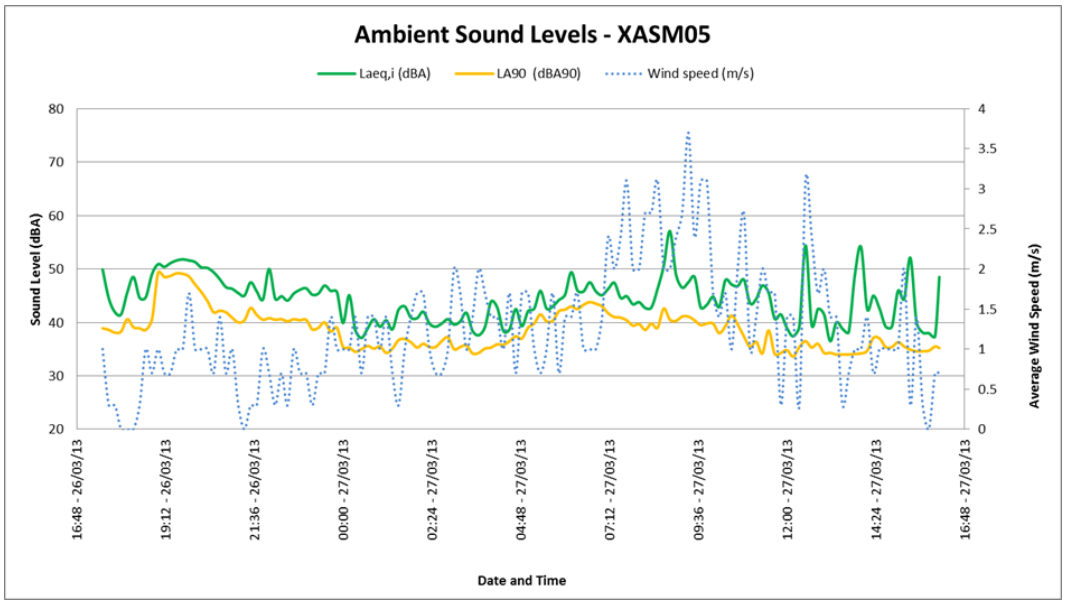

Figure 2.18.3.5 (a): Ambient Sound Levels at XASM05 (26th – 27th March)

Third octave spectral analysis: Third octaves were measured and are displayed in Figure 8 11, Figure 8 12 and Figure 8 13.

Lower frequency (20 – 250 Hz) – Noise sources of significance in this frequency band would include nature (wind especially) and sounds of anthropogenic origin, especially vehicles. Lower frequencies can travel further through the atmosphere than higher frequencies. As with most of the measurements, the measurements reflect significant acoustic energy in these frequency bands, likely relating to traffic on the R565 as well as wind impacts.

Third octave surrounding the 1000 Hz – This range contains energy mostly associated with human speech (350 Hz – 2500 Hz; mostly below 1,000 Hz) and dwelling noises. A few measurements reflected this signature, although most measurements were devoid of these tell-tale peaks/bumps.

Higher frequency (2,000 Hz upwards) – Smaller faunal species such as birds, crickets and cicada use this range to communicate and hunt etc. Night-time samples clearly reflect these sounds from approximately 8 PM till approximately 5 AM the following day, with distinctive peaks at 3,150 – 4,000 Hz (frogs and crickets) and 12,500 – 16,000 Hz (cicada, frogs and other insects). Surprising only one measurement illustrated sounds from bats.

Spectral data analysis concludes that the area has few anthropogenic activities impacting on ambient sound levels with faunal and other natural sounds dominating the ambient soundscape.

LAmax night-time occurrences: A number of instantaneous noise events occurred in the area during night-time measurement hours (13 events where sound levels exceeded 65 dBA out of 137 measurements). The reason is undefined but is likely due to animal sounds close to the measurement position. Maximum noise events may affect sleeping patterns in humans.

C-weighted (LAIeq) vs. A-weighted (LAIeq): Lower frequency was not analysed during measurement dates.

Sounds heard during measurements dates: Traffic on the R565, bird and insects. While data indicates the presence of an industrial noise it was not identified during the site visits.

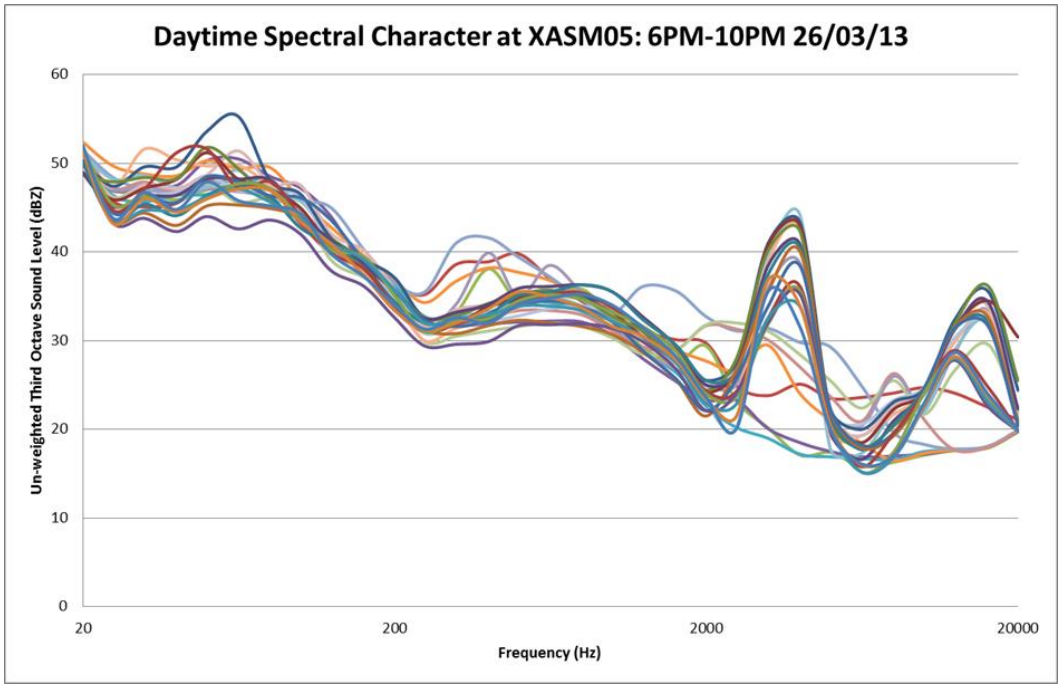

Figure 2.18.3.5 (b): Spectral Frequency Distribution as measured on-site at XASM05 – afternoon and evening

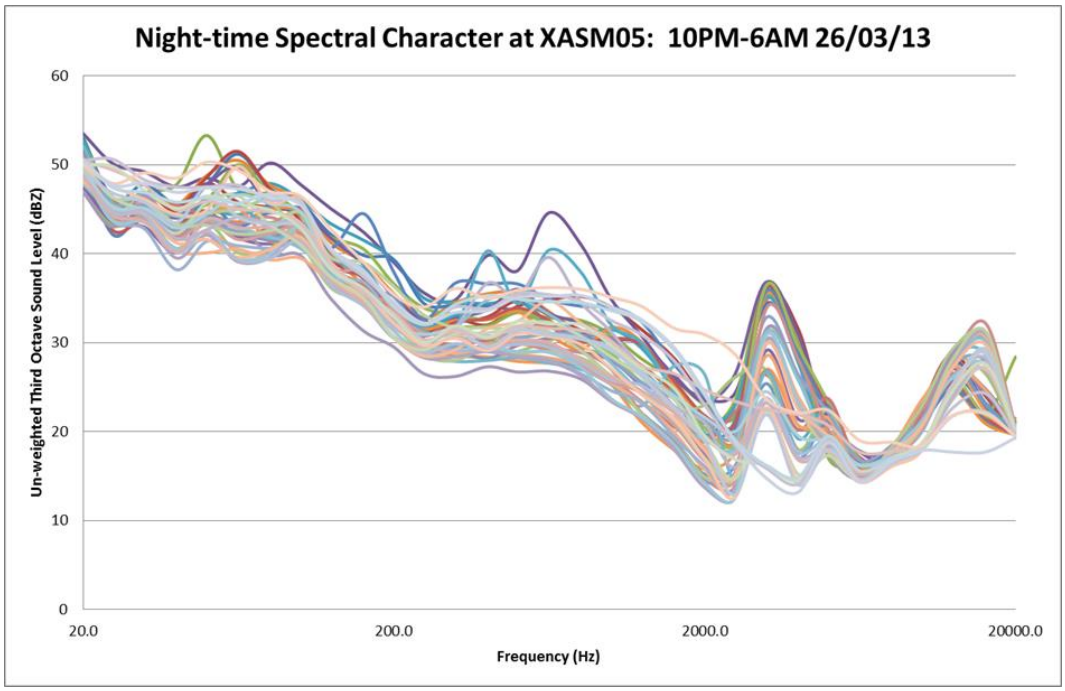

Figure 2.18.3.5 (c): Spectral Frequency Distribution as measured on-site at XASM05 – night-time

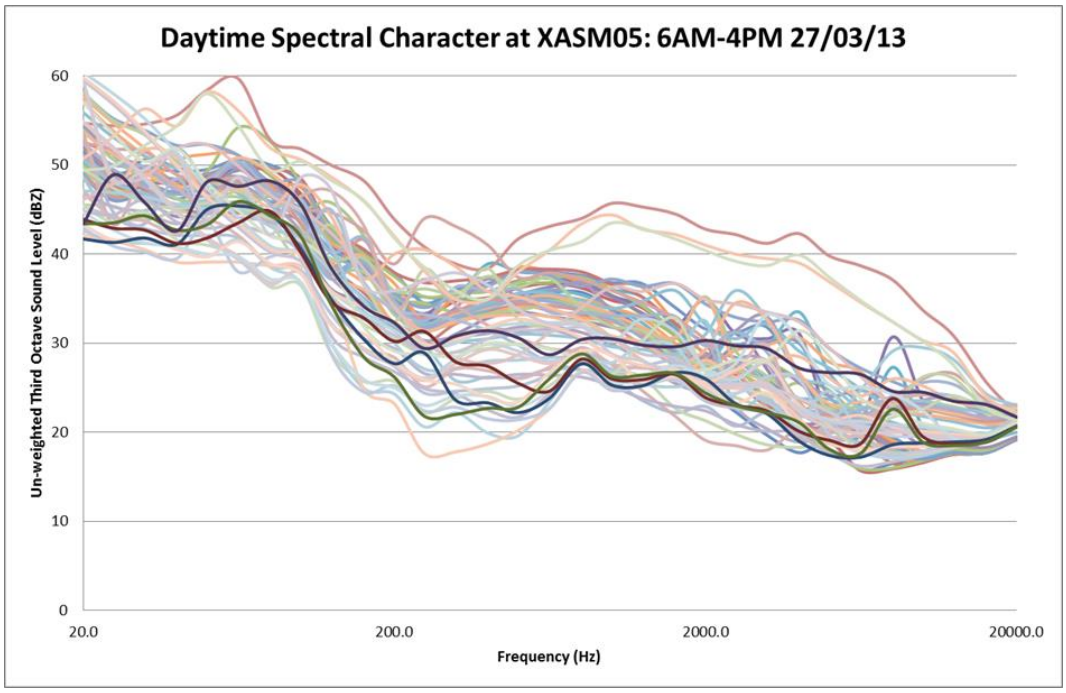

Figure 2.18.3.5 (d): Spectral Frequency Distribution as measured on-site at XASM05 – morning and day

SANS 10103 Rating Level: Measured data indicated a SANS 10103:2008 rating level of "Rural district"; (45/35 dBA day/night rating).

2.18.4 Summary of Noise Base Line Findings

The ambient sound measurements indicated that the ambient sound environment is relatively noisy especially closer to the mining activities, the R565 road as well as the railway line (including the siding). Ambient sound levels are lower the further one move from the R565 and the commercial, industrial and mining activities in the area.

The sound levels in the Rasimone residential community (in area where a measurement was collected) is a combination of music, voices and other noises typical of an urban area. Sounds from mining or industrial sources were not audible at this measurement location.

Measurements locations close to the R565 and the railway line showed noise levels significantly higher than the recommended rating levels for residential areas (SANS 10103:2008).

The R565, industrial and mining activities did change the sound character of the area as confirmed by the measurement results.

2.19 TRAFFIC ASPECTS BASELINE

ITS Engineers was subcontracted by JMA Consulting to perform a Traffic Base Line and Impact Assessment for the Glencore Merafe Boshoek Mine and Smelter (GMBS). A summary of the Base Line report is presented below and the complete Traffic Specialist Baseline Report is attached as **APPENDIX 2.19 (A)** to this report.

2.19.1 Introduction

A Baseline Traffic Assessment was prepared in support of the environmental authorisation processes in respect of the MPRDA, NEMA and NWA for a brownfields Chrome Mine and Ferrochrome Smelter operated by the Glencore Merafe Venture at Boshoek in the North-West Province, approximately 30 km to the north-west of Rustenburg CBD.

The purpose of the Base Line Traffic Assessment is to support an EIA/EMP process with the primary aim of arriving at appropriate mitigation measures to minimise the impact of the GMBS operations on the road network.

This report only addresses the scoping investigation, which includes baseline information, guidelines to be used for the investigation and assessment methodology.

The Traffic Impact Study to follow at a later stage will address the projection of the future traffic demand (background and development traffic), the re-evaluation of the road network to accommodate the future traffic demand and mitigation measures will be proposed to minimise the impact on the external road network.

2.19.2 Proposed Activities

The existing site is located on both sides of the D1813 road and consists of Opencast Mining, a Concentrator Plant, as well as a Ferrochrome Smelter. The proposed new activities will entail the upgrading and replacement of existing plant and facilities for *inter alia* slag and slimes disposal. An additional concentrator JIG plant is also proposed.

2.19.3 Locality

The site falls within the Rustenburg Local Municipality within the Bojanala Platinum District Municipality. The location of the GMBS site is shown in Figure 2.19.3 (a).

2.19.4 Methodology of Assessment

The scoping investigation was carried out as follows:

- Identification of the affected external roads
- Status quo investigation of internal and external road network:
  - Existing traffic volumes, and
  - Basic road network investigation

Capacity evaluation of the existing road network

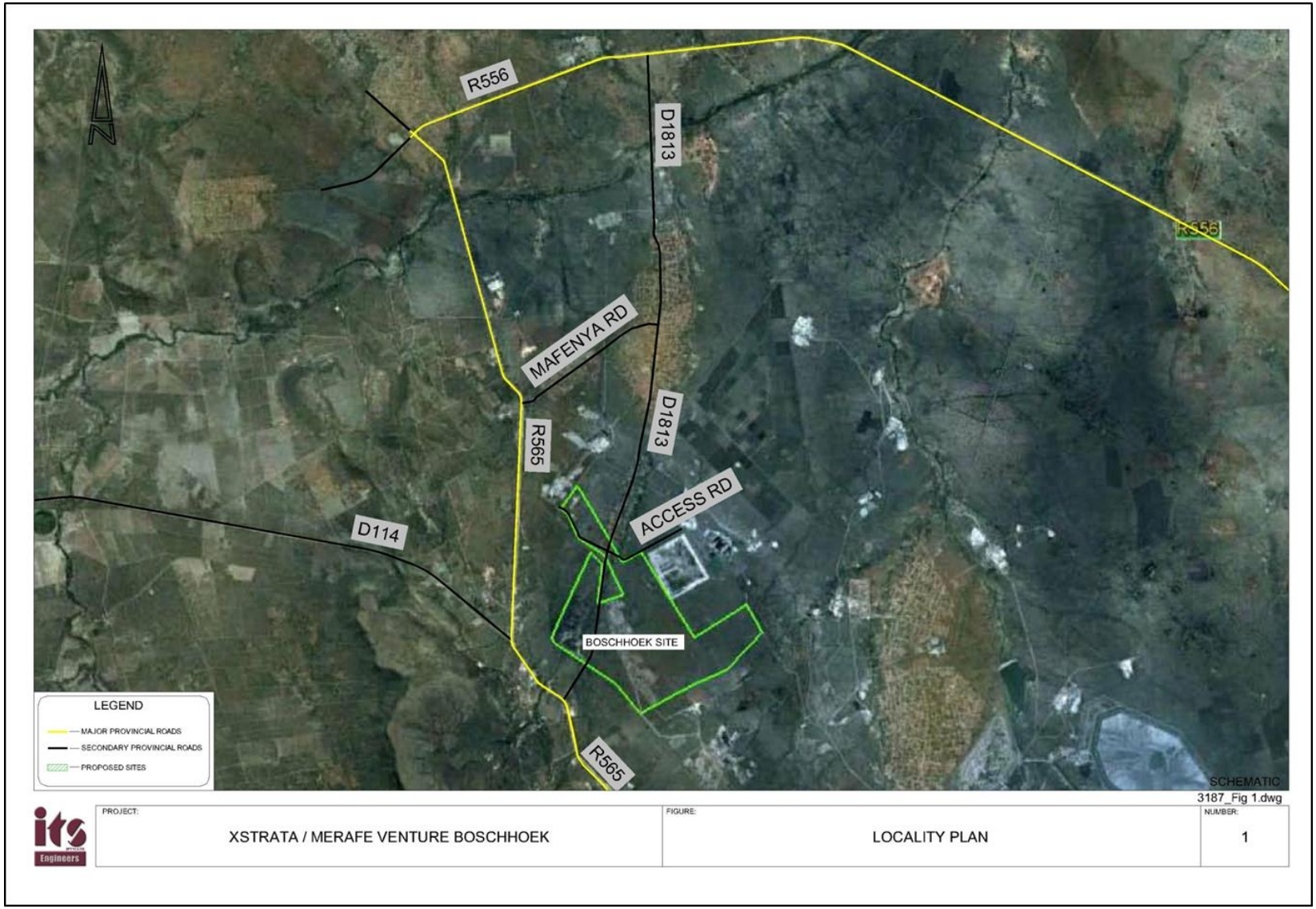

Figure 2.19.3 (a): Site Locality with Relevant Access Roads

2.19.5 Baseline Information

The preferred access road alternatives (if any) will be considered as part of the traffic impact study for the EIA process. At this stage of the project it is expected that the following roads and intersections (see Figure 2.19.3 (a)) might possibly be affected by the proposed development and will therefore be investigated:

- R565 Road;
- D1813 Road;
- D556 Road; and
- Mafenya Road.

2.19.6 Status Quo

Classified Traffic counts were carried out on Wednesday, 11th April 2013 for 12 hours (6:00 - 18:00) at the above mentioned intersections. Light vehicles, heavy vehicles (1 – 4 axles) and very heavy vehicles (>5 axles), were counted at the intersections.

The AM and PM Peak hour was determined based on the highest traffic volumes registered during the morning and afternoon periods respectively. The AM Peak was found to be from 05:45 to 06:45 and the PM Peak hour was recorded at 17:30 to 18:30.

Approximately 17% of the counted AM peak hour traffic volumes and approximately 12% of the counted PM peak hour volumes are heavy vehicles.

The baseline AM and PM peak hour total traffic volumes are indicated in Figure 2.19 (c)

The analysis indicate that the intersections currently operating satisfactory on level of service (LOS) ranging between A and D during the morning AM and afternoon PM peak hour as indicated in Figure 2.19 (d) and Figure 2.19 (e).

2.19.7 Road Condition

The R565 and R556 roads are currently used as the major access roads for operational purposes of the GMBS operations.

The D1813 road, a north-south road and the D513, an east-west road carries relatively low volumes of traffic during the morning and afternoon peak hours.

The R565 road is an existing two lane surfaced road and forms part of the major road network from Rustenburg to the rest of the road network in the North West Province.

The R556 road is an existing two lane surfaced road and links the R565 road with the Pilanesberg area and currently the major link road between Sun City and the Gauteng area.

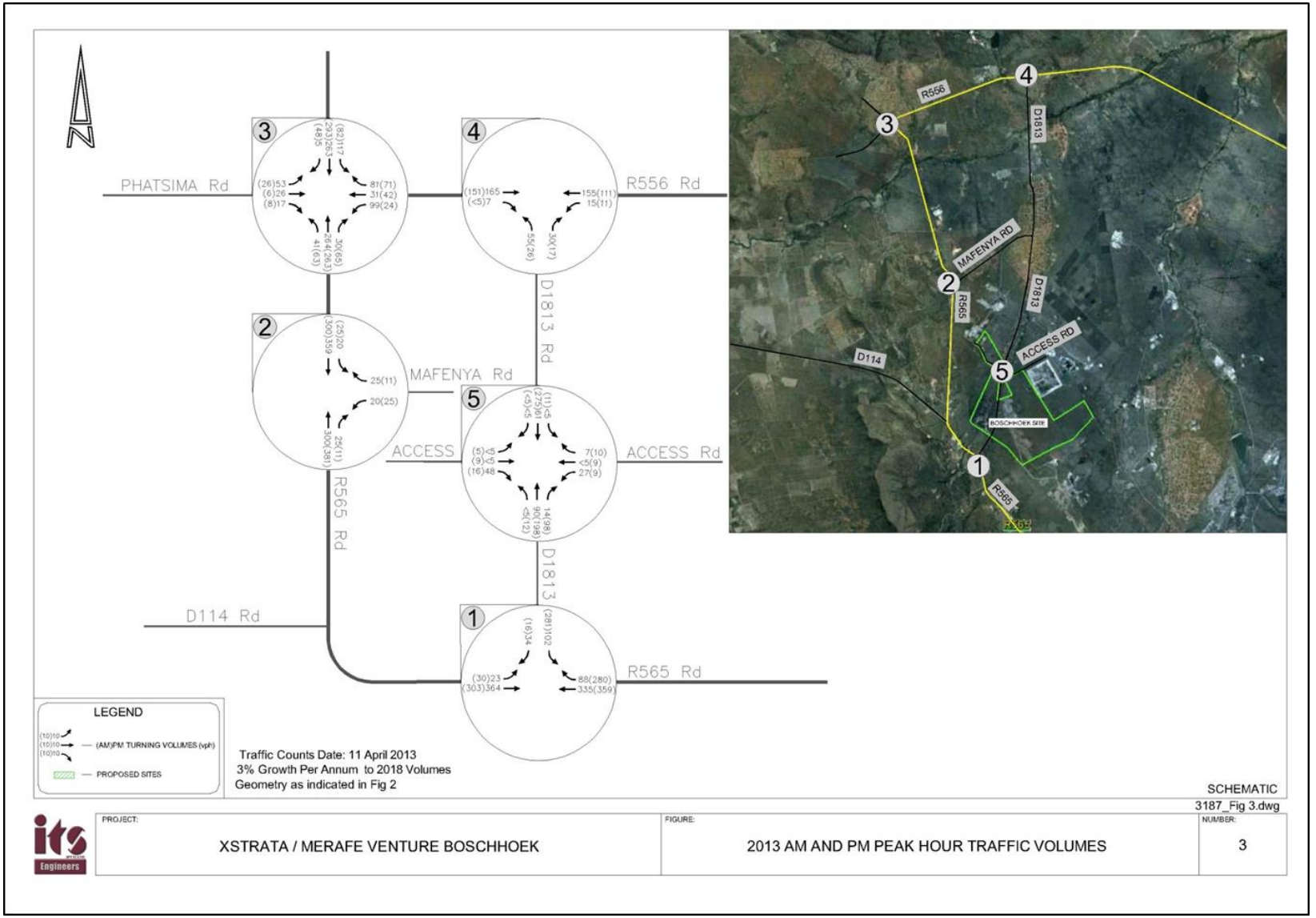

Figure 2.19.6 (a): 2013 AM and PM Peak Hour Traffic Volumes

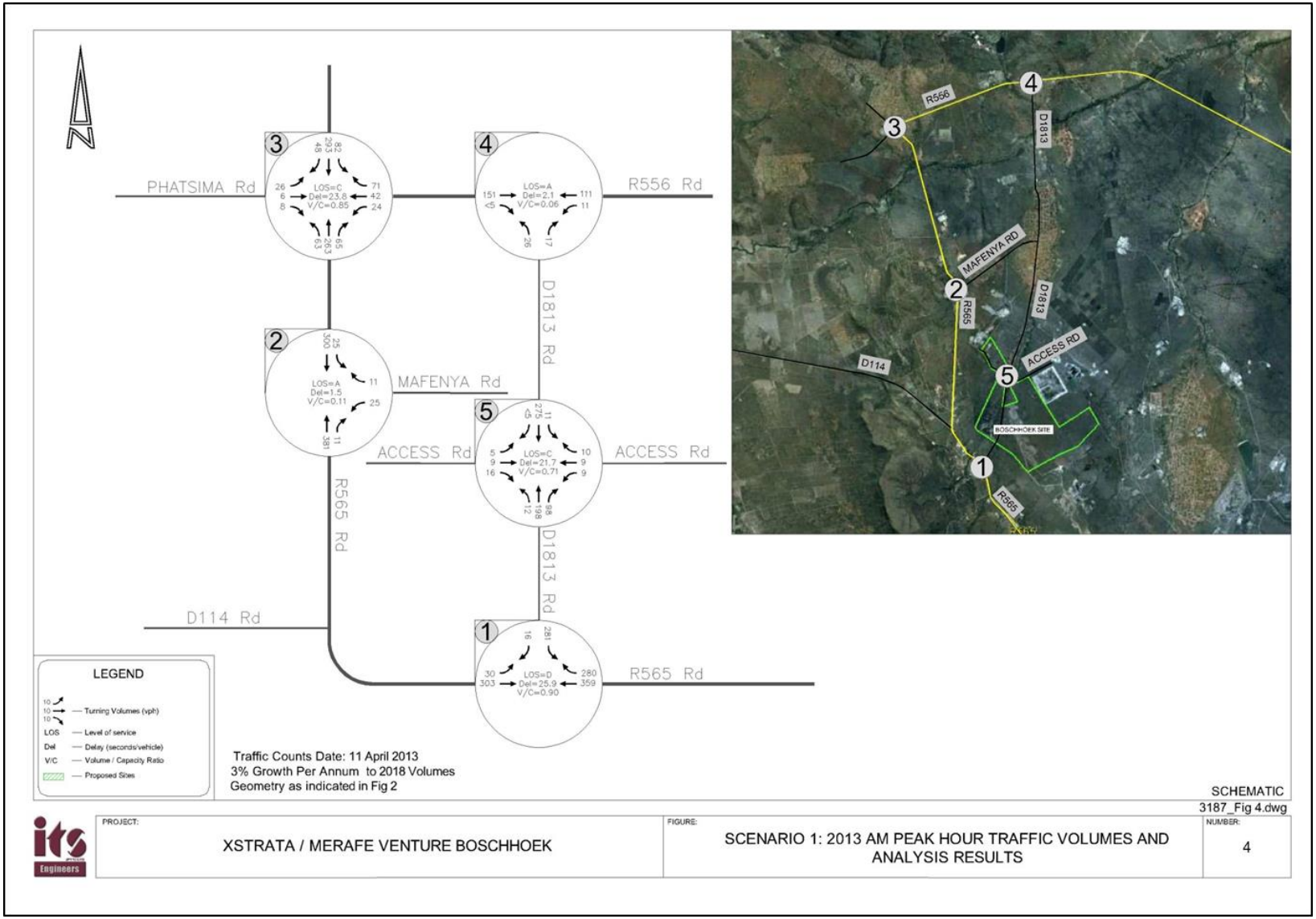

Figure 2.19.6 (b): 2013 AM Peak Hour Traffic Volumes and Analysis Results

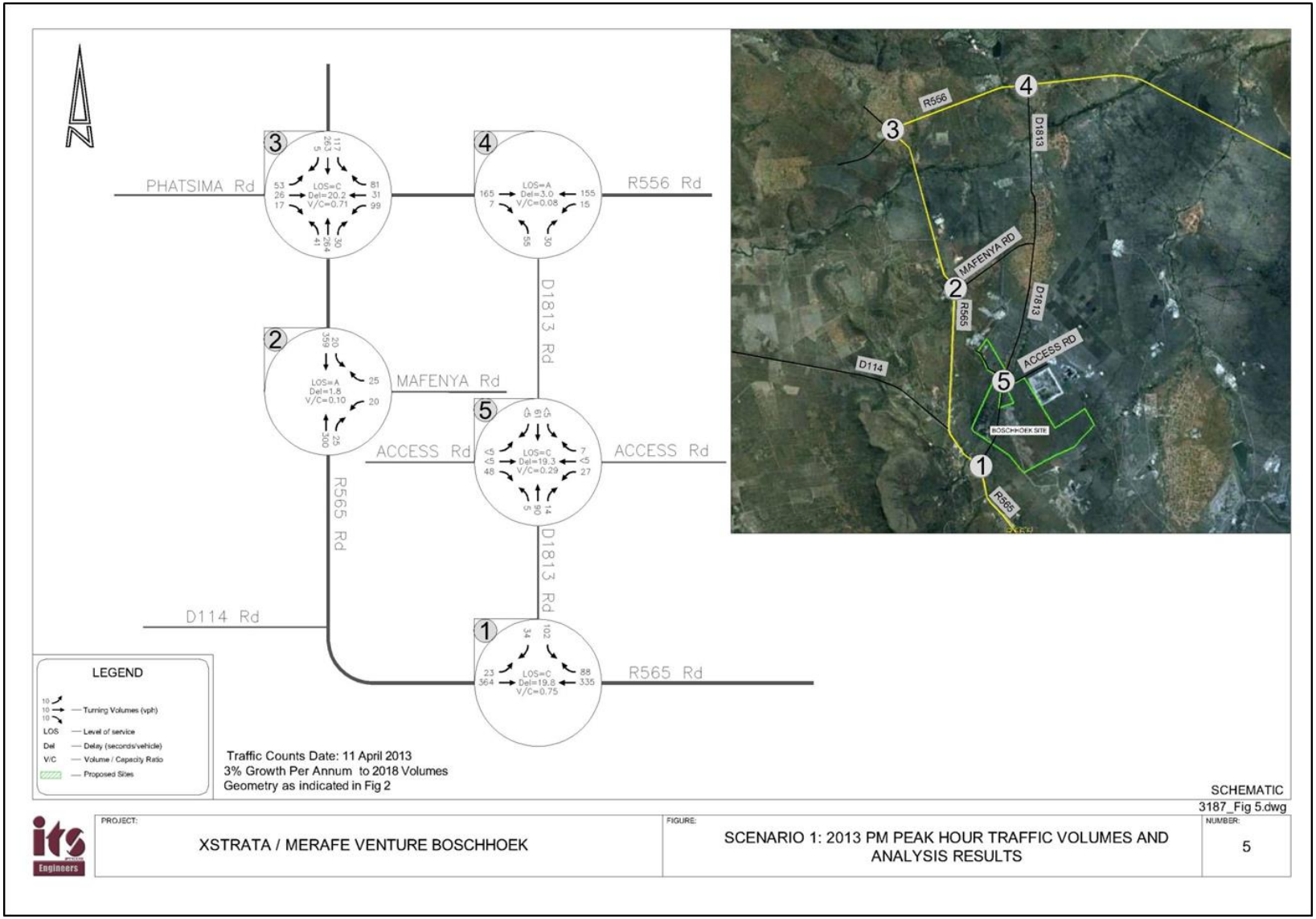

Figure 2.19.6 (c): 2013 PM Peak Hour Traffic Volumes and Analysis Results

The traffic volumes on the R565 / R556 road are mainly traffic from Rustenburg to the Pilanesberg area as well as to the surrounding mining and farm areas. The R565 and R556 carries approximately 1 200 vph and 290 vph in both directions respectively. During the afternoon peak hour the main direction on the R565 is southbound towards Rustenburg with approximately 460 vph in a southerly direction.

The traffic volumes on the Mafenya Village road0, D1813 and D513 are less than 100 vph in both directions during the peak hours. Traffic on the Mafenya Village road and D1813 is mainly traffic to and from Chaneng Village and between Rustenburg and the mining areas.

2.19.8 Intersection Geometry

The current intersection geometry is indicated on Figure 2.19.8 (a).

- The D565 / D1813 road intersection is currently a priority controlled intersection with priority on D565.
- The D565 / Mafenya road intersection is currently a priority controlled intersection with turning lanes on the approaches of the D565 road.
- The D565 / D556 road intersection is currently a four way stop controlled intersection with turning lanes on the approaches of the D565 road.
- The D556 / D1813 road intersection is currently a priority controlled intersection with priority on D556 and with turning lanes on the approaches of the D556 road.

All the intersections analysed are currently operating at acceptable levels of service and delay.

2.19.9 Access to the GMBS Operations

The main access to the GMBS operations would be from the D1813 via the R565 and R556 roads.

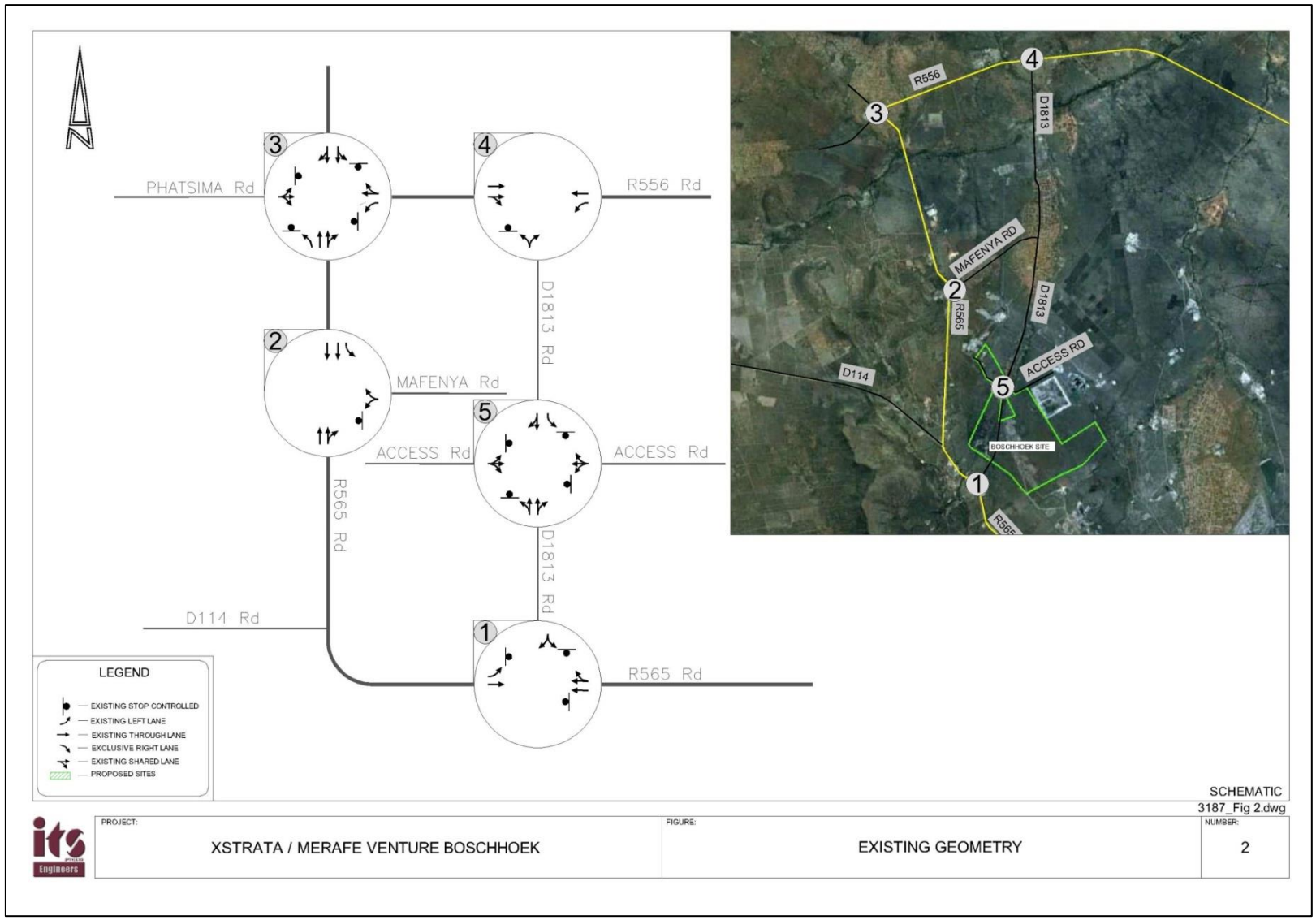

Figure 2.19.8 (a): Existing Intersection Geometry